# CARNIVORE ABUNDANCE AND DISTRIBUTION THROUGHOUT THE PUENTE/CHINO HILLS

**Final Report-1999**

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# INTRODUCTION

Habitat fragmentation has been targeted as one of the most serious threats to biodiversity worldwide (Wilcox and Murphy 1985; Soule 1991a) and in areas with increasing urbanization, fragmentation is virtually inevitable (Soule 1991b). Indeed, intensive development in southern California over the past century has destroyed most of the native coastal sage scrub and chaparral habitats (Westman 1987). This massive habitat loss, in conjunction with the high levels of local endemism of native species, has helped create a "hot-spot" of extinction in the region (Myers 1990; Dobson et al. 1997).

One of the principal factors contributing to habitat fragmentation has been the construction of roadways (Meffe et al. 1997). Not only do these roadways separate previously connected areas of habitat they also create a barrier effect for organisms attempting to move between patches (Jackson and Griffen 1998). A barrier effect can have detrimental impacts on local populations in that, over time, populations restricted to these patches may experience a reduction in genetic diversity due to increased inbreeding, increased risk of local extinction due to population dynamics and catastrophic events, and decreased ability to recolonize (Yanes et al. 1995). In addition, increasing highway mortality also plays a role in eliminating more individuals from a population (Harris and Gallagher 1989). Aside from fragmenting habitat, roadways also create edges that would otherwise be absent in undisturbed conditions (Reed et al. 1996).

Species that display a high vulnerability to fragmentation include those that are wide-ranging, exhibit low population densities, or are large patch or interior dwelling species (Noss and Csuti 1997). Large mammals, particularly carnivores, exhibit these characteristics but their decline in fragmented systems has received little attention (but see Beier 1995). Further, the disappearance of top predators from fragmented systems may have community-wide implications (Robinson 1953, 1961; Linhart and Robinson 1972; Sargeant et al. 1983; Voight and Earle, 1983; Schmidt 1986; Johnson et al. 1989; Sovada et al. 1995; Ralls and White 1995). Dominant carnivores can suppress smaller carnivores through both competition and predation (Voight and Earle, 1983; Sargeant et al. 1987; Theberge and Wedeles 1989; Harrison et al. 1989). Consequently, the decline of top predators in fragmented areas may lead to the ecological release of smaller predators that in turn can exert strong predation pressure on prey species. Such "mesopredator release" (Soulé et al. 1988; Crooks and Soulé 1999) has been implicated in the decline and extinction of prey species worldwide (Willis and Eisenmann 1979; Matthiae and Stearns 1981; Whitcomb et al. 1981; Sargeant et al. 1983; Wilcove et al. 1986; Soulé et al. 1988; Terborgh 1988; Sovada et al. 1995; Crooks and Soulé 1999).

To counteract the negative effects of fragmentation on populations, the concept of corridors has been proposed. The exact definition of a corridor varies and can include habitat, greenbelts, biogeographic landbridges, refuge systems, and underpasses (Simberloff et al. 1992). Generally, the accepted definition describes a corridor as a linear habitat, embedded in a dissimilar matrix, that connects two or more larger blocks of habitat (Beier and Noss 1998). Additionally, it is recognized that the corridor is proposed for conservation on the grounds that it will enhance or maintain the viability of specific wildlife populations. (Rosenberg et al. 1997). Noss (1987) suggests several potential advantages to corridors including increased species richness and diversity, decreased probability of extinction, maintenance of genetic variation, a greater mix of habitat and successional stages, and an alternative refugia from large disturbances. Alternatively, Simberloff and Cox (1987) provide potential disadvantages to corridors including the facilitation of epidemic diseases, outbreeding depression, facilitation of the spread of fire, and increased exposure to humans.

In certain situations, particularly within an urban environment, maintaining these connections may be virtually impossible, as many urbanized localities have irreversibly fragmented habitats. In fact, Adams and Dove (1989) suggest that recreation values have received greater attention than biological considerations in planning and managing linkages through urban areas. Despite the possible advantages to maintaining some degree of conductivity within an urban landscape, several factors typically associated with the urban/wildland interface may cause corridors to be ineffective. First, human activity may have an adverse affect on animal movement patterns. Second, domestic animals, as well as opportunistic or exotic species may inhibit movement by native species. Finally, the presence of roadways may act as a mortality sink, as animals attempt to negotiate their way from one patch to another.

To counteract the negative impact that roadways have on animal movement, the role of underpasses as an alternative route to surface crossings has received increasing attention. However, few studies have attempted to determine the effectiveness of varying roadway underpass dimensions for wildlife species (but see Reed et al. 1975, Yanes et al. 1995, Foster and Humphrey 1995, Clevenger 1998, Clevenger 2000).

## Study Area

The Puente-Chino Hills represent a continuous series of undeveloped open spaces consisting of both private and public lands, extending west from CA Route 91 in Orange and Riverside Counties to I-605 in Los Angeles County, California (Figure 1). This 50 km long stretch of hills is entirely surround by urbanization with two exceptions: the eastern end is linked to the Santa Ana Mountains (Cleveland National Forest) by the Coal Canyon Biological Corridor and the western end is physically linked to the San Gabriel Mountains (Angeles National Forest) by the San Gabriel River. The connection at the eastern end is far more intact than that at the western end, although recent development threats have jeopardized this linkage. Coal Canyon extends almost 3 km from Cleveland National Forest to the Santa Ana River, Featherly Regional Park, and Chino Hills State Park. While a majority of the habitat is still intact between these locales, development pressure has threatened to sever this connection.

The western connection is comprised of a 20 km stretch of the San Gabriel River, the majority of which is channelized and lacks vegetation. Therefore, it is highly unlikely that the San Gabriel River is a viable connection between the Angeles National Forest and the western Puente Hills. Due to the extreme separation of the western end from a core area, the Puente-Chino Hills, at a regional scale, more closely resemble a peninsula of habitat extending from the Santa Ana Mountains into the urban matrix of the Los Angeles Basin. On a local scale, however, the open space connecting Chino Hills State Park with the Whittier Hills does represent a potential animal movement corridor.

Aside from connections to the Santa Ana and San Gabriel Mountains, additional patches of open space are located near the Puente-Chino Hills and include the San Jose Hills and the Prado Flood Control Basin (Figure 1). The San Jose Hills are separated from the

Puente Hills by CA 60 and the Prado Flood Control Basin is separated from the eastern Chino Hills by CA 71. While these areas are not contained within the linear east-west series of connected open space, they represent additional areas of habitat that may harbor local populations of plant and animal species. Although sampling did not occur in the San Jose Hills, surveys were conducted within the Prado Flood Control Basin in conjunction with the CA 71 Carnivore Telemetry Project.

The Puente/Chino Hills corridor is widest at Chino Hills State Park, where it stretches almost 9 km across Orange, Riverside, and San Bernardino Counties. Further west, at Harbor Blvd., it narrows to a 1.5 km wide area of open space. From Harbor Boulevard to Colima Road, the average width of the corridor is approximately 1 km. In the Whittier Hills, the width of open space widens to almost 3 km. The western end of the hills is bordered by Workman Mill Road in the vicinity of I-605.

Eleven roadways of varying widths bisect the corridor (Figures 2, 3). The easternmost roadway, CA Route 91, divides the Santa Ana Mountains and Chino Hills State Park. To the northeast, CA 71 divides the Chino Hills and the Prado Flood Control Basin. Continuing west, the corridor is bisected by Carbon Canyon Road (CA 142), CA Route 57, Brea Canyon Road, Harbor Boulevard, Fullerton Road, Hacienda Boulevard, Colima Road, Turnbull Canyon Road, and Workman Mill Road/I-605. These roadways represent potential barriers to wildlife movement across the corridor, as they have fragmented the remaining open space into eight patches of varying sizes.

## RESEARCH GOALS

The goals of this study were to 1) evaluate the relative abundance of large and medium-bodied mammals throughout a fragmented landscape and 2) determine the relationship between mammal usage and underpass (including bridge, tunnel, and culvert) variables.

We surveyed each section of the corridor for the entire suite of large and medium-bodied mammal species in order to obtain the relative abundance of each species across the study area. Specifically, our target species included mountain lion, mule deer, coyote, bobcat, gray fox, raccoon, striped skunk, long-tailed weasel, and the non-native opossum, domestic cat, and domestic dog. Sites were selected based on access and represented city, county, and state lands, including utility right-of-ways. Additionally, we monitored roadway underpasses (including bridges, tunnels, and culverts) to identify which species were utilizing these structures.

## METHODS

The entire study area was divided into seven sections. Each section was separated from adjacent sections by major roadways (Figures 2 and 3):

1. CA 91 to Carbon Canyon Road (CA 142), including CA 71 and Prado Flood Control Basin
2. Carbon Canyon Road (CA 142) to CA 57
3. CA 57 to Harbor Boulevard
4. Harbor Boulevard to Hacienda Boulevard
5. Hacienda Boulevard to Colima Road
6. Colima Road to Turnbull Canyon Road
7. Turnbull Canyon Road to I-605

Several sampling techniques were conducted to document distribution and relative abundance for the target species in each section: 1) track surveys, 2) scat surveys, 3) remotely triggered camera surveys. From each of these surveys, an index of relative abundance of each species was obtained. Relative abundance for each species was compared among sites throughout the study area.

### Track Surveys

Forty-two track transects were established along dirt roads and wildlife trails throughout the corridor. Scent stations were established along 1000 m transects with five stations at approximately 250 m intervals. In cases where the roadway was the transect (e.g.

Carbon Canyon and Turnbull Canyon), stations were placed at roadside pullovers or where drainages crossed the roadway. Generally, each transect consisted of five stations, however due to constraints on sampling area some transects contained less. In addition, 13 individual track stations, not part of continuous track transects, were placed throughout the corridor in areas where access was limited and/or a transect was not feasible.

Each scent station consisted of a 1 $m^2$ plot of finely sifted gypsum powder and a rock baited with two artificial scent lures (Russ Carman's Pro Choice and Canine Call) placed in the middle of the station. Stations were checked for visitation for five consecutive mornings in order to record visitation by rarer species. Upon visitation, tracks were identified to species, cleared, and resifted. The artificial scent lures were applied every other day.

Scent stations were surveyed during the summer/fall seasons of 1997 and 1998. Some transects were surveyed an additional season during the winter of 1998. Rains during the winter and spring seasons made track surveys difficult to execute, as the gypsum powder was inoperable if wet.

To obtain an index of relative abundance the number of visits by each species was divided by the total sampling effort. This index was calculated using the following equation:

$$I = \ln \{v_j/(s_j n_j) + 1\}$$

where, $I$ = index of carnivore activity at transect j
$v_j$ = number of stations visited by species to transect j
$s_j$ = number of stations in transect j
$n_j$ = number of nights that stations were active in transect j

Any scent station in which tracks were too difficult to read was omitted from the sampling night. Thus the true sampling effort was:

$$(s_j n_j) - o_j$$

where, $o_j$ = number of omits in transect j

This index only portrays the relative abundance of species within a particular transect. These indices do not provide data on the absolute number of individuals. Instead the index is used to compare relative abundance of species across space and time.

**Scat Surveys**

Thirty-two scat transects were established along dirt roads and wildlife trails throughout the corridor. Scat surveys, conducted for coyote, bobcat, and fox, coincided with track surveys and were conducted during the summer/fall seasons of 1997 and 1998. Transects were cleared of all scat following termination of track surveys. Two collections were made at 2 and 4 weeks after the initial clearing. Each scat was identified to species and ranked on a confidence scale of 1 to 3, with 3 being the highest confidence level of species identification. Those scat which were rated 2 and 3 were included in the analysis.

The index of relative abundance was calculated using the following equation:

$$I = \ln \{(s_j/m_j/d_j)+1\}$$

where, I = index of carnivore activity at transect j
$s_j$ = number of scats collected from transect j
$m_j$ = length of transect j
$d_j$ = number of days during which scats were deposited on transect j

This index only portrays the relative abundance of species within a particular transect. These indices do not provide data on the absolute number of individuals. Instead the index is used to compare relative abundance of species across space and time.

**Camera Surveys**

Camtrak cameras (Camtrak South Inc, 1050 Industrial Drive, Watkinsville, GA 30677) were used to complement track and scat surveys. Cameras were placed along scat and track transects wherever the probability of theft was low. Otherwise, cameras were placed along a wildlife trail or a portion of a streambed paralleling the road in order to reduce its detectability by humans. Each wildlife pass by the sensor triggered the camera. Date of pass, and in some instances time of day, were recorded on each print. Visits were made to each camera location periodically to replace batteries and film. Cameras were operated during the summer and fall seasons of 1997. Unfortunately, there was a high level of theft at many camera locations.

## Underpass Surveys

Any mammal species attempting to cross a roadway from an adjacent fragment would have two options: an at-grade, or surface, crossing or utilizing an underpass. While it is difficult to determine where animals are making at-grade crossings, several track transect or individual scent stations attempted to document potential crossing locations. Individual scent stations were placed along several roadways, including Brea Cutoff Road, Fullerton Road, and Colima Road. Track transects were established along Carbon Canyon Road and Turnbull Canyon Road.

Underpasses are easier to monitor and provide a safe alternative to at-grade crossing attempts. Three types of underpasses were monitored: highway bridges, tunnels, and culverts. Highway bridges include any open span. Tunnels are defined as those underpasses designed for equestrian, vehicular, or wildlife uses. Culverts refer to any underpass that is primarily designed for drainage purposes. We monitored 42 underpasses including 1 highway bridge, 9 tunnels (including 3 wildlife tunnels, 3 vehicle service tunnels, and 3 equestrian tunnels), and 32 culverts. We then attempted to determine if species usage was related to the dimensions of underpasses.

Underpasses were monitored using two methods. One, remotely triggered cameras were stationed at the entrances to culverts. These cameras were secured to a wooden stake driven into the ground. The stake and camera were placed along the headwall of the culvert at a distance of 1 m from the culvert entrance. Film and batteries were checked at least every two weeks, with more frequent checkups occurring at culverts with higher wildlife activity. Species usage was determined by dividing the number of pictures of each species through the underpass by the number of days the camera was active. Species direction of travel and time of pass were also recorded.

A second method used to monitor culvert usage was sifting gypsum powder across the floor of the underpass. Tracks left by individuals passing through the underpass were identified to species. Direction of travel was also recorded. Species usage was recorded as the number of times a given species used the underpass divided by the number of days the underpass was sampled.

We measured nine underpass dimensions and five landscape variables to describe each roadway underpass (Table 1 – see end of report). The dimension of each underpass is presented in Table 2 (see end of report). We then estimated species usage of each underpass through three different indices: an index for species recorded at underpasses monitored by track stations, an index for species recorded at underpasses monitored by cameras, and an index for species recorded at underpasses that were monitored by both track and camera stations. There was no difference in index values for each species obtained by either track or camera methods ($t = 1.80$, $p = 0.073$), therefore index values obtained by combining both methods were used in our statistical analyses.

We then related species usage of an underpass to the underpass dimensions. For each species, we only included underpasses where that species was recorded on either side of the roadway. For each continuous underpass variable, a t-test was used to determine if the average dimension for underpasses used by species was significantly different than the average dimension for underpasses not used by that species. For each categorical underpass variable, a Chi-Square test was used to determine if a specific type of underpass category was used more or less frequently than other types of underpass categories.

## RESULTS

### Track, Scat, and Camera Surveys

### Section 1: CA 91 to Carbon Canyon Road (CA 142)

Large portions of open space within this section of the corridor are public lands including Featherly Regional Park, Chino Hills State Park, and Carbon Canyon Regional Park. Additionally, the Army Corps of Engineers manages Prado Flood Control Basin, a large reserve that contains standing water throughout most of the year. Sampling was focused on three areas: Featherly Regional Park, Chino Hills State Park, and the Prado Flood Control Basin, which includes CA 71 and surrounding ranch land.

**Featherly Regional Park**

*Track Surveys*

Sampling around Featherly Regional Park was focused along CA 91 from Coal Canyon Road to Gypsum Canyon Road (Figure 4). Three transects and a single scent station were established within and around Featherly Regional Park and included:

1. Bike Path - that portion of the bike path along CA 91 between Coal Canyon Road and Featherly Regional Park
2. Santa Ana River- an equestrian trail paralleling the Santa Ana River between Coal Canyon and Featherly Regional Park
3. Railroad West- a railroad access road between Brush Canyon Park and Green River Golf Course
4. Coal Canyon- a single scent station placed along Coal Canyon Road at the southeast corner of the CA 91/Coal Canyon Road interchange.

Coyote visitations occurred on all of the transects in the Featherly Park region (Table 3). Bobcat activity was concentrated south of the Santa Ana River, most likely due to the high amount of vegetation along the river channel. Interestingly, bobcats were not detected along the bike path transect during the summer and fall season of 1997, which coincided with construction of the Eastern Transportation Corridor Foothill Freeway on the adjacent CA 91. The Coal Canyon station was visited by coyotes (track index = 0.194). Although no mountain lions were detected on track stations, mountain lion activity in Featherly Regional Park was reported to a park ranger in August 1998. Additionally, mountain lion tracks were identified along the bike path while hiking during a preliminary investigation of Featherly Regional in May 1997.

**Table 3. Track indices for transects in the region of Featherly Regional Park.**

| Transect | BOB | COY | FOX | OPO | RAC | SKU | DOG |
|---|---|---|---|---|---|---|---|
| Bike Path | 0.015 | 0.175 | 0.000 | 0.015 | 0.029 | 0.000 | 0.246 |
| Santa Ana River | 0.018 | 0.201 | 0.000 | 0.054 | 0.000 | 0.000 | 0.380 |
| Railroad West | 0.000 | 0.369 | 0.013 | 0.040 | 0.000 | 0.127 | 0.207 |
| Coal Canyon* | 0.000 | 0.194 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

*= indicates a single scent station

*Scat Surveys*

Scat surveys were conducted along the Bike Path and Railroad West transects (Figure 4). No scat was detected along the bike path (Table 4). This may reflect the high degree of human activity along this road, as scats deposited were most likely run over by bikes, thus lowering detection. Coyote and fox scat were collected along the railroad transect.

**Table 4. Scat indices for transects in the region of Featherly Regional Park.**

| Transect | COY | FOX |
|---|---|---|
| Bike Path | 0.00000 | 0.00000 |
| Railroad West | 0.00012 | 0.00001 |

*Camera Surveys*

Cameras were placed at two underpasses underneath CA 91. Results from these surveys are presented in the underpass monitoring section of this report.

**Prado Flood Control Basin/ CA 71**

*Track Surveys*

Four transects were placed on the east and west sides of CA 71 (Figure 5). Transects on the east side of CA 71 included:

1. Prado- portions of two access roads within Prado Flood Control Basin

2. Dam- a scent station on the east and west ends of Prado Dam

3. Railroad East- three scent stations located along the railroad access road 1 km west of Auto Center Drive

A single transect on the west side of CA 71 included:

1. Hanger Ridge- a ranch-owned dirt road running along a large north-south ridge paralleling CA 71.

Four transects were placed perpendicular to CA 71, with stations within the transect placed on the east or west side of the freeway (Figure 5). These transects included:

1. Canyon 4- a dirt road owned by a ranch and Orange County Flood Control District, 1 km south of the CA 71/Euclid Avenue interchange

2. Canyon 6- a dirt road owned by a ranch and Orange County Flood Control District, 1 km south of the CA 71/Euclid Avenue interchange

3. Spillway- a Prado Flood Control Basin access road paralleling the south side of the Santa Ana River

4. Santa Ana River Trail (S.A.R.T.)- including a portion of a service road paralleling the north side of the Santa Ana River.

The dam was sampled to determine if movement was occurring across it, however only dog tracks were recorded. Bobcat and fox activity was recorded in three of the eight transects (Table 5). Fox and raccoon activity on the Canyon 4 and Canyon 6 transects, which ran perpendicular to the freeway, were only recorded on the east (Prado Flood Control Basin) side of CA 71. Deer activity at scent stations was recorded at Canyon 6 (track index = 0.009). This was complemented by deer sightings along this same transect. Deer sightings were also recorded along the Santa Ana River Trail (S.A.R.T.) and in Canyon 4 (Lisa Lyren, personal communication). Badger tracks were detected along the Santa Ana River in February 1997.

**Table 5. Track indices for transects along CA 71.**

| Transect | BOB | COY | DEER | FOX | OPO | RAC | SKU | DOG |
|---|---|---|---|---|---|---|---|---|
| Prado[e] | 0.000 | 0.470 | 0.000 | 0.000 | 0.140 | 0.049 | 0.000 | 0.372 |
| Dam[e] | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.560 |
| Railroad East[e] | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.118 |
| Hanger Ridge[w] | 0.000 | 0.588 | 0.000 | 0.000 | 0.000 | 0.000 | 0.095 | 0.000 |
| Canyon 4[b] | 0.044 | 0.594 | 0.000 | 0.150 | 0.035 | 0.009 | 0.094 | 0.009 |
| Canyon 6[b] | 0.018 | 0.578 | 0.009 | 0.128 | 0.053 | 0.000 | 0.070 | 0.036 |
| Spillway[b] | 0.000 | 0.511 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.080 |
| S.A.R.T. [b] | 0.021 | 0.261 | 0.000 | 0.021 | 0.042 | 0.000 | 0.000 | 0.000 |

e= indicates transect is on the east side of CA 71
w= indicates transect is on the west side of CA 71
b= indicates transect is on both sides of CA 71

*Scat Surveys*

Scat surveys were conducted on three transects along CA 71 including Canyons 4 and 6 and the Santa Ana River Trail. Bobcat, coyote, and fox scat were detected in both canyons (Table 6). Only coyote scat was detected along the Santa Ana River Trail.

**Table 6. Scat indices for transects perpendicular to CA 71.**

| Transect | BOB | COY | FOX |
|---|---|---|---|
| Canyon 4 | 0.00002 | 0.00016 | 0.00004 |
| Canyon 6 | 0.00002 | 0.00014 | 0.00002 |
| S.A.R.T | 0.00000 | 0.00006 | 0.00000 |

*Camera Surveys*

Cameras were placed at underpasses underneath CA 71. Results from these surveys are presented in the underpass monitoring section of this report.

## Chino Hills State Park

### *Track Surveys*

Four transects were established in Chino Hills State Park and included:

1. Aliso Canyon (Figure 5)- beginning at the southern entrance to Chino Hills State Park
2. East Ridge (Figure 5)- part of the East Ridge Trail at the eastern boundary of Chino Hills State Park
3. Telegraph Canyon East (Figure 6)- a section of the Telegraph Canyon Trail, just west of "Four Corners"
4. Telegraph Canyon West (Figure 6)- western end of the Telegraph Canyon Trail, beginning at the Carbon Canyon entrance of Chino Hills State Park

Sampling in the two major drainages of Chino Hills State Park showed that these canyons are high areas of activity, especially for bobcats (Table 7). East Ridge, although lacking bobcat visits, showed relatively moderate levels of coyote and fox activity and had the highest levels of skunk activity. While no deer tracks were recorded on track stations, occasional sightings were made in south Aliso Canyon and Telegraph Canyon. Weasel visits to scent stations were recorded in Telegraph Canyon East (.021) and Telegraph Canyon West (.021). Mountain lion sightings were also reported to park rangers in August 1998. These sightings included separate visuals of two adults and a juvenile in the vicinity of North Aliso Canyon, South Ridge, and Water Canyon.

**Table 7. Track indices for transects in Chino Hills State Park.**

| Transect | BOB | COY | FOX | OPO | RAC | SKU | WEA | DOG |
|---|---|---|---|---|---|---|---|---|
| Aliso Canyon | 0.059 | 0.511 | 0.087 | 0.000 | 0.030 | 0.030 | 0.000 | 0.087 |
| East Ridge | 0.000 | 0.256 | 0.041 | 0.080 | 0.000 | 0.118 | 0.000 | 0.000 |
| Telegraph Canyon East | 0.193 | 0.581 | 0.042 | 0.000 | 0.082 | 0.021 | 0.021 | 0.082 |
| Telegraph Canyon West | 0.071 | 0.577 | 0.000 | 0.048 | 0.093 | 0.093 | 0.021 | 0.275 |

*Scat Surveys*

Coyote and fox scat were detected on all four transects within Chino Hills State Park (Table 8). Bobcat scat was detected at all transects except East Ridge.

**Table 8. Scat indices for transects in Chino Hills State Park.**

| Transect | BOB | COY | FOX |
|---|---|---|---|
| Aliso Canyon | 0.00010 | 0.00062 | 0.00023 |
| East Ridge | 0.00000 | 0.00050 | 0.00005 |
| Telegraph Canyon East | 0.00043 | 0.00050 | 0.00020 |
| Telegraph Canyon West | 0.00007 | 0.00007 | 0.00011 |

## Section 2: Carbon Canyon Road (CA 142) to CA 57

The area between Carbon Canyon Road and the CA 57 was not sampled completely due to access restraints. The recent acquisition of the Shell property by Chino Hills State Park provided the opportunity to survey Sonome Canyon. Additional surveys were conducted at the western end of this section in Tonner Canyon. Sampling was not conducted between western Tonner Canyon and Sonome Canyon due to the restriction of access onto the Firestone Boy Scouts Reservation. Because the habitat throughout the Reservation is similar to Tonner and Sonome Canyons, carnivore activity in the Firestone Property should be similar to carnivore activity to the west and east. In fact, due to the lack of human activity on the Firestone property, certain species may possibly have higher index values than those in Sonome and Tonner Canyon.

### Carbon Canyon Road

*Track Surveys*

Seven scent stations were placed along the shoulder of Carbon Canyon Road from Olinda Drive west to Chino Hills State Park (Figure 6) and included:

1. Located on the north side of Carbon Canyon Road, just east of its intersection with Olinda Drive
2. Located on the south side of Carbon Canyon road, just east of its intersection with Olinda Drive
3. Located on the north side of Carbon Canyon Road, 0.70 km west of Olinda Drive
4. Located on the north side of Carbon Canyon Road, 0.85 km west of Olinda Drive
5. Located on the north side of Carbon Canyon Road, 1.08 km west of Olinda Drive
6. Located on the south side of Carbon Canyon Road, 1.23 km west of Olinda Drive
7. Located on the south side of Carbon Canyon Road, 1.31 km west of Olinda Drive

Stations were placed at locations along the road where large drainages crossed. Due to the proximity of the stations to the road, surface crossings over Carbon Canyon Road, particularly by coyotes, could be documented simply by following the remnants of gypsum powder left by the pads of the individual visiting the scent station. Table 9 shows indices for individual scent stations along Carbon Canyon Road. These indices represent abundance levels at one particular location, not over an entire transect. After visiting the stations, coyote tracks either traversed the edge of the roadway or crossed the roadway at all scent stations. Actual crossings were recorded at stations 1, 3, 4, and 7. These sites do not imply that crossings are occurring at these sites alone, rather they can be used to establish which of the sampled locations along Carbon Canyon Road are receiving the highest levels of activity.

**Table 9. Track indices for scent stations along Carbon Canyon Road.**

| Station | COY | SKU | DOG |
|---|---|---|---|
| 1 | 0.286 | 0.000 | 0.000 |
| 2 | 0.333 | 0.000 | 0.143 |
| 3 | 0.857 | 0.143 | 0.000 |
| 4 | 0.833 | 0.000 | 0.000 |
| 5 | 0.857 | 0.000 | 0.000 |
| 6 | 0.429 | 0.000 | 0.000 |
| 7 | 1.000 | 0.000 | 0.000 |

*Scat Surveys*

Since scent stations along Carbon Canyon Road were not established within a transect, rather they were placed at locations where side canyons crossed the road, a scat transect was not feasible. Scat was collected within 50 m of each scent station in two transects on either side of the road. The purpose of this was to document activity within a certain section of the roadway. The presence of scat along the road does not infer that animals were making crossing attempts, however it does indicate portions of the road where wildlife is active. The highest numbers of scats were collected between stations 6 and 7 (Table 10), however a majority of these were ranked as a 1 (high uncertainty in species identification). Coyote scat was detected at stations 3-7. Fox scat was collected at station 4. Scat was also collected at stations 1, and 2 however the species depositing the scat could not be determined.

**Table 10. Scat indices for stations along Carbon Canyon Road.**

| Station | COY | FOX |
|---|---|---|
| 1 | 0.00000 | 0.00000 |
| 2 | 0.00000 | 0.00000 |
| 3 | 0.00033 | 0.00000 |
| 4 | 0.00050 | 0.00017 |
| 5 | 0.00083 | 0.00000 |
| 6 | 0.00083 | 0.00000 |
| 7 | 0.00067 | 0.00000 |

**Sonome Canyon**

*Track Surveys*

Four transects were established on the State Park property (Figure 6) and included:

1. Shell Canyon- paralleling the north side of Carbon Canyon Road, across from the citrus grove

2. Sonome Canyon East- beginning on the eastern side Olinda Village, at the end of Olinda Drive

3. Sonome Canyon- located along a dirt road paralleling the streambed

4. Sonome Canyon West- beginning at the west end of Olinda Village, at the end of Lilac Drive

Table 11 provides track indices for the four transects. The Sonome Canyon region had the highest level of bobcat and fox activity within the whole corridor. This is probably most likely due to its relative isolation, lack of human disturbance, and relatively large areas of habitat. Deer activity was recorded on two transects: Sonome Canyon East (track index = 0.113) and Sonome Canyon West (track index = 0.077). Coyote activity was exceptionally high on the Shell Canyon transect; bobcat and fox visits were also recorded on this transect.

**Table 11. Track indices for transects in the Sonome Canyon region.**

| Transect | BOB | COY | DEER | FOX | SKU | DOG |
|---|---|---|---|---|---|---|
| Shell Canyon | 0.100 | 0.906 | 0.000 | 0.051 | 0.100 | 0.051 |
| Sonome Canyon East | 0.215 | 0.247 | 0.113 | 0.000 | 0.000 | 0.077 |
| Sonome Canyon | 0.039 | 0.113 | 0.000 | 0.000 | 0.000 | 0.000 |
| Sonome Canyon West | 0.083 | 0.361 | 0.077 | 0.298 | 0.043 | 0.197 |

*Scat Surveys*

All four transects in the Sonome Canyon region had evidence of bobcat, coyote, and fox (Table 12). Shell Canyon had the highest scat index for coyote and fox, and Sonome Canyon had the highest scat index for bobcats.

**Table 12. Scat indices for transects in the Sonome Canyon region.**

| Transect | BOB | COY | FOX |
|---|---|---|---|
| Shell Canyon | 0.00015 | 0.00092 | 0.00026 |
| Sonome Canyon East | 0.00004 | 0.00007 | 0.00004 |
| Sonome Canyon | 0.00034 | 0.00034 | 0.00008 |
| Sonome Canyon West | 0.00003 | 0.00020 | 0.00007 |

*Camera Surveys*

A camera placed at the eastern scent station on the Shell Canyon track transect recorded four species (Table 13). Although bobcat and fox were detected on both track and scat surveys, they were never detected by camera surveys.

**Table 13. Camera indices for the Shell Canyon transect.**

| COY | DEER | SKU | DOG |
|---|---|---|---|
| 1.125 | 0.125 | 0.125 | 0.125 |

## Tonner Canyon

*Track Surveys*

Two transects and two individual scent stations were established in Tonner Canyon (Figure 7):

1. Tonner Canyon East- an oil company road paralleling the Tonner Canyon streambed
2. Tonner Canyon West- an oil company road travelling under the CA 57 overpass
3. Tonner Canyon Road- a single scent station located along Tonner Canyon Road, under the CA 57 overpass
4. Brea Canyon Road- a single scent station at the Brea Canyon Road/CA 57 interchange

Although the western portion of the Tonner Canyon West transect lies within Section 3, results are presented in this section to compare index values on either side of the roadway. The open span bridge carrying CA 57 over Tonner Canyon provides unrestricted movement of wildlife under the freeway. Furthermore, due to restrictions on public access in this area, human impact is relatively low, as supported by the fact that no dogs visited transects in Tonner Canyon; dogs were recorded further north at the Brea Canyon Road scent station. Coyote and fox activity occurred on both track transects on the Tonner

Canyon Road scent station (Table 14). Bobcat visits were only documented at the Tonner Canyon Road scent station, underneath the freeway overpass; several bobcat sightings also occurred near this station. Deer activity was documented on the Tonner Canyon East transect and sightings have occurred on the north side of Tonner Canyon on the Brea Cañon Oil Company Property. Several mountain lion sightings were reported by employees of both oil companies, but these reports have not been verified. However, a mountain lion radio-collared by Beier was known to traverse portions of this area (Beier 1993).

**Table 14. Track indices for transects in Tonner Canyon.**

| Transect | BOB | COY | DEER | FOX | OPO | RAC | SKU | DOG |
|---|---|---|---|---|---|---|---|---|
| Tonner Canyon East | 0.000 | 0.875 | 0.095 | 0.095 | 0.000 | 0.095 | 0.095 | 0.000 |
| Tonner Canyon West | 0.000 | 0.241 | 0.000 | 0.192 | 0.167 | 0.000 | 0.030 | 0.000 |
| Tonner Canyon Road* | 0.182 | 0.182 | 0.000 | 0.182 | 0.588 | 0.000 | 0.000 | 0.000 |
| Brea Canyon Road* | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.400 |

*= indicates a single scent station

*Scat Surveys*

Only coyote scat was detected on the Tonner Canyon East transect (Table 15). Coyote and fox scat were detected on the Tonner Canyon West transect. It should be noted that scat persistence along these transects was low due to the high degree of heavy equipment and machinery. Therefore, most of the scat deposited on this transect were most likely crushed. Scat indices presented here may underestimate actual values.

**Table 15. Scat indices for transects in Tonner Canyon.**

| Transect | COY | FOX |
|---|---|---|
| Tonner Canyon East | 0.00014 | 0.00000 |
| Tonner Canyon West | 0.00003 | 0.00006 |

*Camera Surveys*

A camera was placed along a wildlife trail paralleling the Tonner Canyon West transect immediately west of CA 57 overpass. Seven wildlife species were recorded (Table 16).

**Table 16. Camera indices for the Tonner Canyon West transect.**

| BOB | COY | DEER | FOX | OPO | RAC | SKU |
|---|---|---|---|---|---|---|
| 0.115 | 0.038 | 0.154 | 0.077 | 0.038 | 0.115 | 0.038 |

## Section 3: CA 57 to Harbor Boulevard

*Track Surveys*

The majority of the open space between these two roadways is owned by Shell Oil Corporation. As a result, surveys were limited to the extreme eastern and western ends of this section. Four transects were placed on the east and west side of Harbor Boulevard (Figure 8). These transects covered the majority of the open space on the east and west of Harbor Boulevard. One transect and a single scent station were placed on the east side of Harbor Boulevard and included:

1. Harbor Central/East- a transect consisting of three stations located on the east side of Harbor Boulevard 0.5 km south of Pathfinder Road

2. Shea- a single scent station located at the extreme southeast corner of the Vantage Pointe Planned Community

Two transects and a single scent station were placed on the west side of Harbor Boulevard and included:

1. Harbor North- a transect consisting of three stations located on the west side of Harbor Boulevard, across from the Rowland Water District Building

2. Harbor Central/West- a transect consisting of three stations on the west side of Harbor Boulevard, along the Edison easement

3. Fullerton Road- a single scent station on the west side of Harbor Boulevard, immediately north of the southern intersection of Harbor Boulevard and Fullerton Road

An additional transect was located perpendicular to Harbor Boulevard and included scent stations east and west of Harbor Boulevard. This transect included:

1. Harbor South- located on the Los Angeles County Department of Public Works property (DPW)

Table 17 provides results for transects on both sides of Harbor Boulevard. Although transects west of Harbor Boulevard are in section 4, they are presented here as a means of comparing index values on either side of the roadway.

Several coyote visits to the Fullerton Road scent station were followed by at-grade crossings over Harbor Boulevard. Additional at-grade crossings by coyotes were recorded on the Harbor South transect. Deer visits were made to a station in the Harbor South transect on the east side of Harbor Boulevard. Surface crossings over Harbor Boulevard by deer were also recorded at this station. Bobcat activity was only recorded west of Harbor Boulevard, along the western edge of Vantage Pointe in the vicinity of the Edison easement. Raccoon activity was only detected east of Harbor Boulevard.

**Table 17. Track indices for transects surrounding Harbor Boulevard.**

| Transect | BOB | COY | DEER | FOX | OPO | RAC | SKU | DOG |
|---|---|---|---|---|---|---|---|---|
| Harbor South[b] | 0.000 | 0.595 | 0.049 | 0.025 | 0.012 | 0.037 | 0.025 | 0.049 |
| Harbor Central/East[e] | 0.000 | 0.658 | 0.000 | 0.000 | 0.000 | 0.000 | 0.034 | 0.159 |
| Shea[e*] | 0.000 | 0.693 | 0.000 | 0.095 | 0.000 | 0.182 | 0.182 | 0.336 |
| Harbor North[w] | 0.000 | 0.336 | 0.000 | 0.000 | 0.125 | 0.000 | 0.065 | 0.154 |
| Harbor Central/West[w] | 0.035 | 0.496 | 0.000 | 0.102 | 0.000 | 0.000 | 0.134 | 0.279 |
| Fullerton Road[w*] | 0.000 | 0.336 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.095 |

b= transects in which stations were distributed on both sides of Harbor Boulevard
e= transects on the east side of Harbor Boulevard
w= transects on the west side of Harbor Boulevard
*= indicates a single scent station

*Scat Surveys*

Coyote and fox scat were collected from all four transects surrounding Harbor Boulevard (Table 18). Bobcat scat was only detected along the Harbor Central/West transect. A single bobcat scat was found on the west side of the Harbor South transect, but it was not collected during the official scat survey sampling period.

**Table 18. Scat indices for transects surrounding Harbor Boulevard.**

| Transect | BOB | COY | FOX |
|---|---|---|---|
| Harbor South | 0.00000 | 0.00083 | 0.00023 |
| Harbor Central/East | 0.00000 | 0.00091 | 0.00065 |
| Harbor North | 0.00000 | 0.00050 | 0.00012 |
| Harbor Central/West | 0.00018 | 0.00063 | 0.00009 |

*Camera Surveys*

Cameras were established along two transects: Harbor South and Harbor Central/West. The camera along the Harbor South transect was placed east of Harbor Boulevard, along the eastern boundary of the DPW property. The camera placed on the Harbor Central/West transect was placed at station 1. Only coyotes were recorded at both camera sites (Table 19). Deer and raccoons were detected along the Harbor South transect.

**Table 19. Camera indices for camera stations surrounding Harbor Boulevard.**

| Transect | COY | DEER | RAC |
|---|---|---|---|
| Harbor South | 0.210 | 0.065 | 0.016 |
| Harbor Central/West | 0.226 | 0.000 | 0.000 |

## Section 4: Harbor Boulevard to Hacienda Boulevard

Sampling within this section was concentrated on two areas: Powder Canyon Open Space and Skyline Trail (Figure 9). This portion of the corridor represents a linear stretch of habitat, dominated by the Skyline Trail, which occupies the major east-west running ridgeline. Many smaller canyons with small portions of habitat drop off to the north and south from the Skyline Trail. Human activity along this stretch of Skyline Trail is extremely high, as supported by the high level of dog indices, which reaches its highest level along this portion of the entire corridor.

## Powder Canyon Open Space

### *Track Surveys*

Three transects and two individual scent stations were placed throughout Powder Canyon Open Space and included:

1. Powder Canyon North- beginning at the northern entrance to Powder Canyon Open Space along Fullerton Road and adjacent to the Water District Headquarters

2. Powder Canyon South- beginning at the middle entrance to Powder Canyon Open Space along Fullerton Road

3. Powder Canyon West- located along Skyline Trail (Drive) in the western portion of Powder Canyon Open Space

4. Powder Canyon Southeast- a single scent station along Fullerton Road placed at the southeast entrance to Powder Canyon Open Space, directly north of the intersection of Fullerton Road and East Road.

5. Pasture- a single scent station placed along Fullerton Road, directly across from the middle entrance to Powder Canyon Open Space.

Scent stations were difficult to monitor throughout Powder Canyon Open Space due to the high level of station disturbance by dogs. Therefore, these index values may underrepresent actual activity levels. In fact, scat surveys throughout this portion and the Skyline Trail portion may prove to be a more accurate indicator of carnivore activity. Bobcat activity was only documented along the northern edge of Powder Canyon Open Space (Table 20). Fox abundance was distributed across all three transects. Deer were commonly seen and tracks were found on all three transects. Coyote tracks often crossed Fullerton Road after leaving the Pasture scent station.

**Table 20. Track indices for transects in Powder Canyon Open Space.**

| Transect | BOB | COY | DEER | FOX | OPO | SKU | DOG |
|---|---|---|---|---|---|---|---|
| Powder Canyon North | 0.033 | 0.348 | 0.033 | 0.049 | 0.065 | 0.182 | 0.336 |
| Powder Canyon West | 0.000 | 0.521 | 0.017 | 0.065 | 0.017 | 0.110 | 0.588 |
| Powder Canyon South | 0.000 | 0.412 | 0.019 | 0.076 | 0.000 | 0.179 | 0.475 |
| Pasture* | 0.000 | 0.182 | 0.000 | 0.000 | 0.000 | 0.000 | 0.336 |
| Powder Canyon SE* | 0.000 | 0.606 | 0.154 | 0.154 | 0.000 | 0.000 | 0.606 |

* indicates a single scent station

*Scat Surveys*

Evidence of bobcat, coyote, and fox scat were found on all three transects (Table 21).

**Table 21. Scat indices for transects in Powder Canyon Open Space.**

| Transect | BOB | COY | FOX |
|---|---|---|---|
| Powder Canyon North | 0.00004 | 0.00072 | 0.00006 |
| Powder Canyon West | 0.00004 | 0.00053 | 0.00008 |
| Powder Canyon South | 0.00002 | 0.00039 | 0.00011 |

**Skyline Trail**

*Track Surveys*

The Skyline Trail was sampled from the western boundary of Powder Canyon Open Space to western boundary of the Edison property. This narrow stretch of habitat consists of a ridgeline bordered by steep canyons to the north and south. These side canyons were inaccessible for sampling purposes, however they may be occupied by rarer species, such as bobcat, that were not detected along Skyline Trail. Dog activity was exceptionally high along this section (Table 22), probably because this is a major recreation path for hikers, bikers, and equestrian riders. No bobcats were detected along this section, possibly due to a combination of human and dog activity and lack of substantial habitat. Deer tracks were also recorded along this section of trail.

**Table 22. Track indices for the Skyline Trail East transect.**

| Transect | COY | DEER | FOX | OPO | SKU | DOG |
|---|---|---|---|---|---|---|
| Skyline Trail East | 0.383 | 0.043 | 0.145 | 0.022 | 0.182 | 0.648 |

*Scat Surveys*

Only bobcat and coyote scat were detected along the Skyline Trail East transect (Table 23).

**Table 23. Scat indices for the Skyline Trail East transect.**

| Transect | BOB | COY |
|---|---|---|
| Skyline Trail East | 0.00003 | 0.00025 |

## Section 5: Hacienda Boulevard to Colima Road

*Track Surveys*

Four transects were established between Hacienda Boulevard and Colima Road (Figure 10). Two of these transects (Hacienda Boulevard and Skyline Trail West) straddled each roadway. Transects included:

1. Hacienda Boulevard- comprised the Skyline Trail from Skyline Drive to the Davies property
2. Skyline Trail West- located along the Skyline Trail and straddling both the east and west sides of Colima Road
3. Whittier East- located on an old oil company road on the former Unocal property
4. Skyline Drive- a single scent station located on the southwest corner of the intersection of Hacienda Boulevard and Skyline Drive

Although the eastern portion of the Hacienda Boulevard transect is located within Section 4, the results are presented here to compare index values across Hacienda

Boulevard. Similarly, although the western portion of the Skyline Trail West transect was located in Section 6, the results are presented here to compare index values across Skyline Trail.

Section 5 is traversed by the Skyline Equestrian Trail and is similar to the previous section in terms of human activity. Fox were not detected along any of the transects along Skyline Trail, however they were detected along the Whittier East transect (Table 24). Bobcat activity was recorded on both sides of Hacienda Boulevard at its' intersection with Skyline Drive. This is also the only site in this section where raccoons were documented. Dog activity was high, likely because the western end of the Skyline Trail West transect was located along a powerline right-of-way through a residential area.

**Table 24. Track indices for transects between Hacienda Boulevard and Colima Road.**

| Transect | BOB | COY | DEER | FOX | OPO | RAC | SKU | DOG |
|---|---|---|---|---|---|---|---|---|
| Hacienda Blvd. | 0.016 | 0.395 | 0.016 | 0.000 | 0.016 | 0.000 | 0.118 | 0.374 |
| Skyline Trail West | 0.000 | 0.201 | 0.014 | 0.000 | 0.014 | 0.000 | 0.142 | 0.460 |
| Skyline Drive* | 0.095 | 0.182 | 0.000 | 0.000 | 0.000 | 0.095 | 0.000 | 0.182 |
| Whittier East | 0.039 | 0.588 | 0.000 | 0.336 | 0.000 | 0.182 | 0.336 | 0.247 |

* indicates a single scent station

*Scat Surveys*

Coyote scat was detected on all three transects (Table 25). Fox scat was not detected on the Skyline Trail West transect. The Whittier East transect was the only transect in this section where bobcat scat was found. Scat surveys did not take place along the Skyline Drive station, as this was a single station and not a complete transect.

**Table 25. Scat indices for transects between Hacienda Boulevard and Colima Road.**

| Transect | BOB | COY | FOX |
|---|---|---|---|
| Hacienda Blvd. | 0.00000 | 0.00019 | 0.00002 |
| Skyline Trail West | 0.00000 | 0.00025 | 0.00000 |
| Whittier East | 0.00022 | 0.00066 | 0.00007 |

## Section 6: Colima Road to Turnbull Canyon Road

*Track Surveys*

Sampling in this section was conducted on property owned by the City of Whittier and managed by the MRCA. This property represents a relatively large area of open space (almost 1200 acres). Three transects were established on this property (Figure 11) and included:

1. Whittier West- located along abandoned oil company roads in Arroyo Pescadero Canyon
2. Whittier Central- located along an abandoned oil road that goes through a service tunnel under Colima Road
3. North Ridge- located along the northern boundary of the property

Bobcat indices were high along two of the three transects (Whittier West and Whittier Central) (Table 26). The North Ridge transect only had coyote and dog activity however all species were recorded in at least one of the two transects in the canyons. Deer activity was recorded on the North Ridge transect and Whittier Central transect and frequently seen throughout the property.

Sampling did not occur between this property and Turnbull Canyon Road due to access restraints from Rose Hills Memorial Park.

**Table 26. Track indices for transects between Colima Road and Turnbull Canyon Road.**

| Transect | BOB | COY | DEER | FOX | OPO | RAC | SKU | DOG |
|---|---|---|---|---|---|---|---|---|
| Whittier West | 0.152 | 0.446 | 0.000 | 0.000 | 0.000 | 0.014 | 0.152 | 0.140 |
| North Ridge | 0.000 | 0.511 | 0.182 | 0.000 | 0.000 | 0.000 | 0.000 | 0.182 |
| Whittier Central | 0.113 | 0.365 | 0.148 | 0.125 | 0.026 | 0.000 | 0.160 | 0.125 |

*Scat Surveys*

Both coyote and fox scat were detected on all three transects in this section (Table 27). Bobcat scat was not detected on the North Ridge transect.

**Table 27. Scat indices for transects between Colima Road and Turnbull Canyon Road.**

| Transect | BOB | COY | FOX |
|---|---|---|---|
| Whittier West | 0.00022 | 0.00066 | 0.00007 |
| North Ridge | 0.00000 | 0.00092 | 0.00021 |
| Whittier Central | 0.00012 | 0.00055 | 0.00024 |

*Camera Surveys*

A camera was placed along a wildlife trail immediately east of station 4 of the Whittier West transect. Bobcat, coyote, and deer were recorded at this location (Table 28).

**Table 28. Camera indices for the Whittier West transect.**

| BOB | COY | DEER |
|---|---|---|
| 0.409 | 0.455 | 0.182 |

## Section 7: Turnbull Canyon Road to Workman Mill Road

A majority of open space surrounding Turnbull Canyon is owned by Rose Hills Memorial so access was limited to sampling along the road. Further west, the Hacienda Hills Open Space and Los Angeles County Landfill were sampled along the Schabarum Equestrian Trail. In addition to human activity, landfill operations, particularly the watering down of dirt roads to reduce dust, made scent stations difficult to operate.

## Turnbull Canyon Road

### *Track Surveys*

Scent stations were arranged in a fashion similar to sampling along Carbon Canyon Road (Figure 12). Eight stations were placed (west to east) between Beverly Hills Drive (in the City of Whittier) and Skyline Drive at points along the road where major drainages crossed. Stations were arranged as follows:

1. Located 0.46 km east of Beverly Hills Drive
2. Located 1.00 km east of Beverly Hills Drive
3. Located 1.62 km east of Beverly Hills Drive
4. Located 1.77 km east of Beverly Hills Drive
5. Located 2.23 km east of Beverly Hills Drive
6. Located 2.54 km east of Beverly Hills Drive
7. Located 2.85 km east of Beverly Hills Drive
8. Located 3.15 km east of Beverly Hills Drive

The proximity of the stations to the road also allowed for the determination of individuals making surface crossings over Turnbull Canyon Road. Coyotes were recorded walking along the side of the road at stations 1, 2, 4, 5, 6, and 7; stations 3 and 8 were not visited by coyotes (Table 29). Deer visited stations 4 and 6 and made a surface crossing at station 4. Dog activity was highest at station 8, which is a dirt pullover used by hikers. Again, these indices represent activity along Turnbull Canyon Road only at a particular station and should not be compared to indices obtained from transects. It should only be used to compare abundance levels at different stations along Turnbull Canyon Road.

**Table 29. Track indices for scent stations along Turnbull Canyon Road.**

| Station | COY | FOX | OPO | RAC | DOG |
|---|---|---|---|---|---|
| 1 | 0.267 | 0.000 | 0.000 | 0.000 | 0.200 |
| 2 | 0.063 | 0.063 | 0.000 | 0.000 | 0.250 |
| 3 | 0.000 | 0.000 | 0.000 | 0.071 | 0.000 |
| 4 | 0.125 | 0.000 | 0.000 | 0.000 | 0.188 |
| 5 | 0.133 | 0.000 | 0.000 | 0.000 | 0.267 |
| 6 | 0.313 | 0.000 | 0.000 | 0.063 | 0.063 |
| 7 | 0.188 | 0.000 | 0.000 | 0.000 | 0.063 |
| 8 | 0.000 | 0.000 | 0.188 | 0.000 | 0.563 |

*Scat Surveys*

Scat surveys along Turnbull Canyon Road followed the same procedures as those on Carbon Canyon Road. Each scat survey coincided with a scent station that was placed along the road. Scat transects were walked on both sides of the road for a distance of 50 m from the scent station. These surveys do not identify the only locations where animals are travel along the road. Rather, they compare the level of activity among those portions of the road that were sampled. Evidence of all three species was detected along Turnbull Canyon Road (Table 30). Bobcat scat was detected around station 3. Fox scat was detected around station 5. Coyote scat was found around stations 7 and 8.

**Table 30. Scat indices for stations along Turnbull Canyon Road.**

| Station | BOB | COY | FOX |
|---|---|---|---|
| 1 | 0.00000 | 0.00000 | 0.00000 |
| 2 | 0.00000 | 0.00000 | 0.00000 |
| 3 | 0.00017 | 0.00000 | 0.00000 |
| 4 | 0.00000 | 0.00000 | 0.00000 |
| 5 | 0.00000 | 0.00000 | 0.00017 |
| 6 | 0.00000 | 0.00000 | 0.00000 |
| 7 | 0.00000 | 0.00017 | 0.00000 |
| 8 | 0.00000 | 0.00017 | 0.00000 |

## Hacienda Hills Open Space/LA County Landfill

*Track Surveys*

Sampling within the Hacienda Hills Open Space and LA County Landfill occurred on three transects (Figures 12, 13):

1. Ford- beginning at the eastern entrance to the Hacienda Hills Open Space (Figure 12)

2. Landfill East- located along the Skyline Trial and beginning at the 7th Avenue Loop

3. Landfill West- located along the Skyline Trail just east of Rio Hondo College

Scent stations on the LA County Landfill transects were difficult to operate to landfill-related activity. In particular, the watering down of landfill roads by water trucks caused all of the scent stations to become inoperable due to their wetness. Therefore, these indices are conservative estimates of distribution and abundance. No bobcats were detected on these transects, whereas coyotes and dogs were common throughout this area (Table 31). Fox and raccoon were detected on the Ford site but not on the landfill, whereas opossum and skunk were detected on the landfill but not on the Ford site.

An interesting note is that the general public has reported evidence of mountain lion activity, either by identifying tracks or observing the animal, several times over the course of this study. Whether or not these reports are accurate, the presence of mountain lions in this section is possible. In fact, a large scat sample was collected in December 1999 on a ridgeline immediately south of Sycamore Canyon (C. Haas). Conclusive identification was difficult due to the age of the sample, however we feel it is possible that this represents additional evidence of mountain lion activity throughout this section.

**Table 31. Track indices for transects between Turnbull Canyon Road and Workman Mill Road.**

| Transect | COY | FOX | OPO | RAC | SKU | DOG |
|---|---|---|---|---|---|---|
| Ford | 0.267 | 0.092 | 0.000 | 0.016 | 0.000 | 0.591 |
| Landfill East | 0.413 | 0.000 | 0.065 | 0.000 | 0.000 | 0.304 |
| Landfill West | 0.251 | 0.000 | 0.082 | 0.000 | 0.182 | 0.082 |

*Scat Surveys*

Due to the high activity of landfill vehicles, scat transects were not conducted along the Landfill East and West transects. Surveys along the Ford transect detected coyote and fox (Table 32).

**Table 32. Scat indices for transects between Turnbull Canyon Road and Workman Mill Road.**

| Transect | COY | FOX |
|---|---|---|
| Ford | 0.00011 | 0.00005 |

## Track Indices of Species Across the Puente/Chino Hills

Track indices for species were plotted from east to west so that relative abundance could be compared along the corridor. For each species, track indices were averaged for each section by summing the index for each transect and dividing by the total number of transects in that section. It should be noted that the number of transects within a section is a function of that section's size; therefore larger sections contained more transects. This could cause a higher variability around the mean track index in smaller sections. Also, some sections were not sampled in their entirety due to access limitations (Sections 3 and 6). As a result, transects did not take into effect the entire section, and therefore provide indices for only a portion of that section. However, these graphs serve to graphically illustrate relative abundance of species throughout the corridor.

Bobcat abundance peaked on both the eastern and western portions of the corridor (Figure 14). Sections 2 and 6 had equal average indices (0.088) and represented the highest level of abundance within the Puente/Chino Hills. Sections 3, 4, and 5 showed a dramatic decrease in abundance.

Coyote abundance was evenly distributed throughout the entire corridor (Figure 15). Relative abundance peaked around Harbor Boulevard and was lowest west of Turnbull Canyon Road. Overall, coyote abundance throughout each section averaged between 0.310 to 0.521.

Although scent stations did not target deer, their average indices in each section were plotted (Figure 16). Section 6 had the highest average relative abundance of all sections (0.110). Average indices varied between 0.010 and 0.041 for Sections 2 through 5. The lowest average indices were in sections 1 and 7. This does not mean that deer were not present in these sections, rather they did not visit scent stations in these sections.

Relative abundance of gray fox peaked at the eastern and western portions of the corridor (Figure 17). These peaks occurred in Sections 2 and 4 and 5, with Section 5 having the highest relative abundance levels. Indices were lower in Sections 1, 3, 6, and 7 and averaged between 0.031 and 0.042.

Opossum abundance varied between 0.026 to 0.036 in Sections 1 through 4 (Figure 18). Sections 5 and 6 showed lower indices. Average relative abundance was highest in Section 7 (0.049).

The average index for raccoons peaked in Section 5 (0.061) but was constant throughout the remainder of the corridor (Figure 19). Average abundance in the other sections was never greater than 0.021.

Skunk abundance also peaked in the middle of the corridor (Figure 20). Section 5 had the highest average index and combined with Section 4, displayed the highest abundance of skunks throughout the entire corridor (0.163 and 0.199 for Section 4 and 5, respectively). The remaining sections had average indices between 0.038 and 0.104.

Weasels were only detected in Section 1 (Figure 21). The average index in that section was 0.003.

Finally, dog abundance peaked between Sections 4 and 5 (Figure 22). Relative abundance in these two sections averaged between 0.360 and 0.512. Abundance was lowest in the eastern half of the corridor, with indices averaging between 0.046 and 0.160. Average indices dropped in Section 6 (0.149), however they increased to 0.326 in Section 7.

## Underpass Surveys

### CA 91

Three underpasses were monitored under CA 91 (Figure 4). They included:

1. East- the easternmost box culvert (within the study area) under CA 91 (Coal Canyon)
2. Central- the centrally located box culvert under CA 91
3. West- the westernmost box culvert under CA 91

The Coal Canyon culvert (East) was the easternmost underpass sampled in the study area. Camera and track stations were inoperable during the winter months due to the high amount of water flowing through this culvert. Track surveys indicate that the East underpass was used by bobcat, domestic cat, and skunk (Table 33). Additionally, a snake passed through this underpass. Skunks used the Central underpass and raccoons used the West underpass.

**Table 33. Track index values for mammals using CA 91 underpasses.**

| Underpass | BOB | RAC | SKU | CAT |
|---|---|---|---|---|
| East | 0.200 | 0.000 | 0.200 | 0.200 |
| Central | 0.000 | 0.000 | 0.200 | 0.000 |
| West | 0.000 | 0.600 | 0.000 | 0.000 |

Camera stations at the East and West underpasses detected several additional species that were not detected by track stations (Table 34). Coyote activity was recorded at the East underpass and opossum and skunk activity were documented at the West underpass. No camera was placed at the Central underpass.

**Table 34. Camera index values for mammals using CA 91 underpasses.**

| Underpass | BOB | COY | OPO | RAC | SKU |
|---|---|---|---|---|---|
| East | 0.063 | 0.063 | 0.000 | 0.000 | 0.000 |
| West | 0.000 | 0.000 | 0.361 | 0.778 | 0.083 |

## CA 71

Twenty-eight underpasses were monitored on CA 71 between Pine Avenue and CA 91 (Figure 5). This portion of CA 71 has been intensively surveyed due to the wildlife crossing study being overseen by CALTRANS. Sampling along this roadway has complemented bobcat and coyote telemetry being conducted by Lisa Lyren. At the conclusion of the telemetry study, specific conclusions and recommendations as to the utility of culvert and fencing design along this freeway will be provided in a final report. The final report will combine results from this study and the telemetry study.

Underpasses were sampled using track stations (Table 35 - see end of report) and camera stations (Table 36 - see end of report). The CA 71 underpasses were the only ones where weasel activity was recorded (Table 35 – see end of report). Deer only used underpass 18. Domestic cat activity was recorded at underpasses 1 and 24. Bobcat activity occurred at 50% of the underpasses, and coyote activity occurred at 74% of the underpasses. Fox were not documented using any of the underpasses under CA 71.

## Carbon Canyon Road

Six underpasses were monitored on Carbon Canyon Road from the Orange/Los Angeles County Line to Carbon Canyon Regional Park (Figure 6). They included:

1. Citrus Grove East- a box culvert at the citrus grove in Chino Hills State Park
2. Citrus Grove West- a round culvert at the citrus grove in Chino Hills State Park
3. Monterey East- a round culvert connecting Carbon County Regional Park and the Monterey property
4. Monterey West- a round culvert connecting Carbon County Regional Park and the Monterey property
5. Church- an arch culvert located near the Olinda Village Church

6. County Line- an arch culvert located directly at the Orange/San Bernardino County Line

Bobcat activity was detected by track stations through the Citrus Grove East underpass (Table 37). Coyotes used the County Line underpass and the western underpass connecting the Monterey Property with Carbon Canyon Regional Park (Monterey West). The only underpass not receiving any carnivore activity was the one located next to the church at Olinda Village (Church).

**Table 37. Track index values for mammals using Carbon Canyon Road underpasses.**

| Underpass | BOB | COY | FOX | SKU |
|---|---|---|---|---|
| Citrus Grove East | 0.333 | 0.000 | 0.167 | 0.167 |
| Citrus Grove West | 0.000 | 0.000 | 0.000 | 0.800 |
| Monterey East | 0.000 | 0.000 | 0.000 | 1.200 |
| Monterey West | 0.000 | 0.200 | 0.000 | 1.000 |
| Church | 0.000 | 0.000 | 0.000 | 0.000 |
| County Line | 0.000 | 0.333 | 0.000 | 0.333 |

Cameras were placed at the Citrus Grove East underpass and the County Line underpass. The camera at the Citrus Grove East underpass recorded bobcat and raccoon activity (Table 38). Bobcat, raccoon, skunk, and opossum activity was documented at the County Line underpass.

**Table 38. Camera index values for mammals using Carbon Canyon Road underpasses.**

| Underpass | BOB | OPO | RAC | SKU |
|---|---|---|---|---|
| Citrus Grove East | 0.208 | 0.000 | 0.042 | 0.000 |
| County Line | 0.167 | 0.033 | 0.033 | 0.066 |

## CA 57

The underpass under CA 57 was the only open span bridge surveyed throughout the entire study area. Sampling underneath the bridge occurred at three locations: along Tonner Canyon Road (an individual scent station), along the Tonner Canyon West transect, and at a camera located on a wildlife trail adjacent to the Tonner Canyon West transect (Figure 7).

These sampling locations were part of the track and camera surveys for the Tonner Canyon portion of Section 2, so all index values are provided in the Tonner Canyon section of the results (Tables 14, 15, 16). Species traveling under the bridge included bobcat, coyote, deer, fox, opossum, raccoon, and skunk.

### Harbor Boulevard

The only underpass under Harbor Boulevard was the equestrian tunnel just south of Pathfinder Road (Figure 8). Only raccoon and skunk were detected using this underpass (Table 39).

**Table 39. Track index values for mammals using the Harbor Boulevard equestrian tunnel.**

| RAC | SKU |
|---|---|
| 0.100 | 0.200 |

### Hacienda Boulevard

The equestrian tunnel under Hacienda Boulevard (Figure 10) was only documented to be used by raccoon and cat (Table 40).

**Table 40. Track index values for mammals using the Hacienda Boulevard equestrian tunnel.**

| RAC | CAT |
|---|---|
| 0.091 | 0.091 |

### Colima Road

Two underpasses were sampled under Colima Road (Figure 11). These included:

1. Colima Road equestrian tunnel- the northern tunnel, in which Skyline Trail goes under Colima Road

2. Service Tunnel- the southern tunnel, an tunnel historically used for oil company operations

Species utilizing the equestrian tunnel included opossum, raccoon, skunk, dog, and cat. The service tunnel was used by bobcat, deer, fox, opossum, and skunk.

**Table 41. Track index values for mammals using Colima Road underpasses.**

| Underpass | BOB | DEER | FOX | OPO | RAC | SKU | DOG | CAT |
|---|---|---|---|---|---|---|---|---|
| Equestrian Tunnel | 0.000 | 0.000 | 0.000 | 0.100 | 0.200 | 0.700 | 0.100 | 0.100 |
| Service Tunnel | 0.438 | 0.625 | 0.125 | 0.063 | 0.000 | 0.313 | 0.000 | 0.000 |

## Underpass Analysis

Results for t-tests and Chi-Square tests on the effects of underpass dimensions on species usage are presented in Table 42 (see end of report). Table 43 (see end of report) presents a summary of those underpass variables that were significantly related to underpass usage of each species.

The type of underpass was an important factor influencing usage for deer and fox. Deer usage was lower than expected at circular underpasses and higher than expected at arch-shaped underpasses, box-shaped underpasses, and open span bridges ($x^2 = 9.73$, $p < 0.021$). Fox usage was lower than expected at underpasses that were circular and arch-shaped and higher than expected at box-shaped underpasses and open span bridges ($x^2 = 23.6$, $p < 0.001$).

Underpass dimensions were important for several species. Deer used underpasses that were significantly higher ($t = 4.01$, $p < 0.001$), wider ($t = 3.49$, $p = 0.001$), and had a greater degree of openness ($t = 3.67$, $p < 0.001$). Indeed, deer were only detected using three of the highest underpasses in the corridor: Culvert 18 under CA 71 (4.57 m), Tonner Canyon bridge under CA 57 (60 m), and the Service Tunnel under Colima Road (5.18 m). The relationship between deer usage and underpass height is depicted as a logistic regression model in Figure 23 (excluding Tonner Canyon in the analyses due to its extreme height value). The combined effect of underpass height and width on deer usage is depicted as a multiple logistic regression model in Figure 24. This figure demonstrates that deer are more likely to use underpasses that are higher and wider.

Foxes used underpasses that were significantly higher ($t = 5.33$, $p < 0.001$), wider ($t = 5.49$, $p < 0.001$), and had a greater degree of openness ($t = 6.15$, $p < 0.001$). Foxes also used underpasses that were longer in length significantly less than underpasses that were shorter in length ($t = 2.06$, $p = 0.045$).

The amount of cover surrounding the culvert entrance was also an important predictor of usage for two species; bobcats and foxes. Underpasses with more natural cover surrounding the entrance were used to a greater degree than those with less natural cover by bobcats ($t = 2.20$, $p = 0.034$) and foxes ($t=2.92$, $p = 0.006$).

The presence of a fence above the underpass was a significant factor determining usage for a few species. Coyotes used underpasses less than expected at areas where there was either no fence or a barbed-wire fence, but higher than expected at areas where there was a 10-ft high chain link fences above the underpass ($x^2 = 6.80$, $p = 0.033$). Foxes used underpasses more than expected at areas where there was either no fence or a barbed-wire fence and less than expected at areas where there was a chain link fence ($x^2 = 6.47$, $p = 0.039$). Raccoons used underpasses more than expected at areas where there was either no fence or a chain link fence, but less than expected at areas that had a barbed wire fence ($x^2 = 7.39$, $p = 0.025$).

The presence of a divider on the freeway (either a guard rail or cement barrier) was a significant factor influencing coyote usage of underpasses. Coyotes used underpasses with no divider on the freeway less than expected and used underpasses where there was a divider more than expected ($x^2 = 17.47$, $p < 0.001$).

Several landscape variables were also important in determining species usage of underpasses. Road density was a significant factor determining underpass use by bobcats; they used underpasses in areas with lower road densities ($t = 3.28$, $p = 0.002$). Bobcats also used underpasses that had a greater amount of wildland (open space) surrounding them ($t = 4.03$, $p < 0.001$) and those with less residential areas in the vicinity ($t = 3.68$, $p < 0.001$). Since a high level of wildland surrounding an underpass would result in a low level of residential area surrounding an underpass, it would be expected that these two variables would be inversely correlated with each other. Furthermore, the degree of residential areas surrounding an underpass would most likely lend itself to higher road densities. Coyotes also used underpasses surrounded by a greater degree of residential areas significantly less than underpasses surrounded by a lesser degree of residential areas ($t = 2.05$, $p = 0.047$).

Corridor width was a significant factor influencing deer usage. Underpasses located in narrow portions of the corridor were used significantly more than underpasses in wide portions of the corridor ($t = 2.54$, $p = 0.015$). Foxes also showed this same trend, using underpasses in narrow portions of the corridor significantly more than underpasses in wide portions of the corridor ($t = 3.74$, $p < 0.001$).

Opossums used underpasses surrounded by a greater degree of residential areas significantly less than underpasses surrounded by a lesser degree of residential area ($t = 2.19$, $p = 0.035$). Raccoons used underpasses located in narrower portions of the corridor significantly more than underpasses in wider portions of the corridor ($t = 2.12$, $p = 0.040$).

Finally, cats used underpasses surrounded by lower levels of wildland ($t = 2.38$, $p = 0.022$), higher levels of residential areas ($t = 2.89$, $p = 0.006$), and higher road densities ($t = 3.32$, $p = 0.002$). Cats also used underpasses in narrower portions of the corridor significantly more than underpasses in wider portions of the corridor ($t = 2.20$, $p = 0.033$).

## DISCUSSION

### Habitat Fragmentation and Mammalian Carnivores in Southern California

Mammalian carnivores are particularly vulnerable to habitat fragmentation and other environmental disturbances; as such, they are valuable indicators of ecosystem health and may be excellent umbrella species on which to base management and conservation strategies (Noss et al. 1996). Our carnivore surveys in fragmented habitat across southern California reveal that carnivore species express differential vulnerability to habitat fragmentation. Crooks (1999) used two separate yet complementary measures to evaluate how landscape variables (patch size, isolation, and age) influence the distribution and abundance of carnivore populations: 1.) Pearson correlation matrices between landscape variables and carnivore track and scat indices (Figure 25), and 2.) incidence functions which calculate the relationship between occupation (the proportion of patches occupied by each species) and landscape variables (Figure 26).

Generally, both measures indicate that mountain lions, bobcats, and spotted skunks are most sensitive to habitat fragmentation; occupancy and abundance increases with fragment size and decreases with age and isolation. Foxes, opossums, raccoons, and domestic cats, however, display the opposite pattern; abundance increases with age and isolation and decreases with patch size. Indeed, both field and questionnaire surveys clearly indicate that these smaller predators are relatively insensitive to habitat fragmentation and fare well in urban situations. Coyote populations, although somewhat more fragmentation-sensitive than the smaller carnivores, experience local extinction only in small, disturbed habitat isolates in the center of the urban matrix (Crooks 1999).

The different responses of southern California carnivore species to habitat fragmentation (see Figures 25, 26) are useful in choosing which species are appropriate targets for conservation programs. Spotted skunks, unlike the larger and more conspicuous striped skunks, are a relatively secretive species with restricted habitat requirements and low population densities (Crooks 1994). As such, spotted skunks are difficult to monitor which limit their utility as target species for management and conservation plans. Nevertheless, the status of the spotted skunk in California is currently unclear, and there is growing concern that the species is becoming rare.

Mountain lions possess large body sizes, home ranges, and habitat requirements and hence are the most sensitive predator species to fragmentation effects (Beier 1993). For this reason, only the largest areas of natural habitat will support viable populations of lions. Specifically, many fragmented areas in southern California are likely too small and isolated to permanently support resident lion populations with long-term viability. Nonetheless, dispersing lions may occasionally enter the western Puente-Chino Hills from the Santa Ana mountains (see Beier 1993). Such events, however, will likely be infrequent and therefore difficult to detect and monitor.

In contrast, coyotes fare well in disturbed urban settings (Figures 25, 26). Indeed, coyotes are widespread and relatively abundant throughout the Puente-Chino Hills (Figure 15). Although we recommend continued monitoring of coyotes throughout the area, there appears to be no immediate threat of local extinction of coyote populations. However, our southern California surveys indicate that coyote populations can experience local extinction in habitat fragments, especially those that are too small, disturbed, or isolated.

Bobcats are intermediate in their sensitivity to habitat fragmentation; they can still exist in fragmented and disturbed habitats, but only those with adequate movement corridors (Figures 25, 26). Bobcats are therefore less sensitive to disturbance than are mountain lions, which seldom use these fragmented areas, yet are more sensitive than coyotes, which can persist in all but the most disturbed habitat isolates. Thus, we suggest that bobcats are excellent target species for which to base future monitoring and management programs in the Puente-Chino Hills.

Bobcats are appropriate target species for several other reasons. First, their solitary nature and relatively large home ranges result in low population densities and high extinction probabilities. Further, bobcats may evoke less concern from urban residents than other species of large native predators. For instance, they pose less threat to humans than do mountain lions, and pose less threat to domestic pets than do coyotes. It may therefore be easier to justify conservation plans for mammalian predators to both funding agencies and the general public if bobcats are presented as the primary target species.

## Mesopredator Release

Given the presence of coyotes throughout the Puente-Chino Hills, the extinction of native prey species through coyote decline and subsequent "mesopredator release" is not an immediate threat. However, even though coyotes are present, we emphasize that mesopredators are still predating on native prey species. Predation by domestic cats is particularly worrisome. Cats, even if well fed by humans, will continue to hunt and kill, sometimes decimating local populations of birds, small mammals, and reptiles. As such, the domestic cat differs from native predators, which often switch to alternate prey as a preferred species becomes scarce.

Further, our research in southern California indicates that coyote populations do decline and disappear in highly isolated fragments, and that as coyotes decline, predation pressure by smaller mesopredators subsequently increases (Crooks and Soulé 1999). Perhaps the most important interaction is that between coyotes and domestic cats. Coyotes will definitely kill domestic cats, as evident by cat remains in areas with coyotes, cat hair in coyote scat, and reports of coyote predation on cats from questionnaire respondents. Further, cats visit the interior of habitat fragments less often when coyotes are present, as evidenced by radio-telemetry data and track surveys. Lastly, questionnaire responses indicate that cat owners, especially those that have previously lost pets to predation, are less likely to let their cats outdoors in areas with coyotes. Thus, the presence of coyotes in these urban natural areas may be beneficial to native species by reducing the visitation rate of domestic cats, a potentially damaging exotic predator.

Consequently, it is essential that the Puente-Chino Hills maintain and develop connectivity to large natural areas that currently contain source populations of top predators such as coyotes. These source areas include larger natural areas in the Santa Ana Mountains and possibly the San Gabriel Mountains. We strongly recommend that resource managers should oppose any "control" of large carnivores such as coyotes in the area. Indeed, in other areas predator control of coyotes has been demonstrated to increase populations of smaller carnivores (Robinson 1953, 1961; Linhart and Robinson 1972), at times to the detriment of native prey species (e.g. ground nesting waterfowl in the Midwest: Sargeant et al. 1983; Schmidt 1986; Johnson et al. 1989; Sovada et al. 1995). Only if coyotes are directly harming populations of threatened or endangered species (such as ground nesting shorebirds) should any control measures be considered.

## Education And The General Public

Acceptance by the general public of carnivore species is essential for their protection (see Kellert et al. 1996). This is especially true in urban settings where human-carnivore interactions are intensified. Kellert et al. (1996) provide general recommendations for education programs to instill more positive attitudes towards carnivores. They emphasize that general information to increase factual knowledge of carnivore species may prove ineffective, sometimes even reinforcing negative attitudes among those already possessing strong views. In addition to simply providing more factual information about a species, they suggest that education programs directly target negative attitudes or beliefs concerning carnivores. They emphasize that rather than simply providing more factual information on a species, education should directly target negative attitudes or perceptions concerning carnivores. We should focus on the public's negative, and often exaggerated, beliefs concerning the threat of predators to both humans and pets. Potential educational options include information dispersal through the local media, distribution of pamphlets and flyers to residents bordering natural areas, and the development of local school programs.

Further, Kellert et al. (1996) stress that education to increase public acceptance of carnivores must emphasize all values represented by these species. They argue that the importance of these species is often limited to their presumed ecological significance (e.g. mesopredator release) or their economic importance. This view ignores many emotional, intellectual, and even spiritual beliefs provided by these charismatic species. They contend that carnivore species offer dimensions of beauty, meaning, quality, and virtue to humans, beyond their ecological or economic significance. Encouragingly, our questionnaire surveys in southern California indicate that residents bordering the natural areas are concerned for the protection of the area and the wildlife within. Citizens generally favor carnivore species in urban natural areas, even those that have lost pets to coyote predation. Moreover, the residents know an impressive amount about the wildlife in their backyards - their responses to the surveys correspond well with our scientific data on the actual distribution and abundance of carnivores in the area.

Nevertheless, despite their conservation concern, many cat owners are unaware of the damage caused by domestic cats, as well as the threats faced by pets that are left outdoors. Most residents let out their cats sometime during the day or night, and less than half of respondents believed that cats were major predators in the canyons. Thus, we recommend that residents be educated, both in terms of threats of coyotes to their cats and the threats of cats to native prey populations. Residents should be urged to keep cats indoors at all times. If not, then cats should at least be kept in at night, as well as much as possible during the breeding and nesting season (spring and early summer) when native prey populations are especially vulnerable.

## Areas of Concern in the Puente/Chino Hills

Habitat fragmentation from a series of roadways in the Puente/Chino Hills has resulted in a chain of various sized patches of open space (Figures 2, 3). Along the entire corridor, three constrictions from encroaching urban development are evident: 1) Harbor Boulevard, 2) the Skyline Trail between Powder Canyon Open Space and Hacienda Boulevard, and 3) the stretch of open space between Hacienda Boulevard and Colima Road. These constrictions are particularly vulnerable to habitat degradation as a result of high human activity. While these activities will most likely not be as serious on wildlife in larger areas of habitat within the Corridor, they are a serious concern in places where habitat is minimal. Therefore, the threat is not entirely due to human activity, rather it is a combination of human activity and lack of suitable habitat.

**Harbor Boulevard**

The first constriction, as one moves east to west, is the area surrounding Harbor Boulevard (Figure 8). The encroachment of development from the north and south has created a narrow stretch of open space on both sides of the roadway. Combined with lack of adequate cover and high traffic volume, movement across this road is dangerous.

The location of the Vantage Pointe Community has split the remaining open space to two choke points along Harbor Boulevard. The first point is at the north end of Harbor Boulevard in the vicinity of the equestrian tunnel. Only raccoon and skunk were detected moving through this tunnel. This tunnel also receives a great deal of human activity. Coyotes are attempting to surface cross Harbor Boulevard at this location, as several road kill were detected over the course of this study.

While it is clear that the northern linkage across Harbor Boulevard (specifically the equestrian tunnel) is functioning for raccoons and skunks, the tunnel was not used by most species (see Recommendations for proposed improvements to this underpass). Although coyotes, foxes, and opossums were detected in the vicinity of the northern linkage, these three species were never detected using the equestrian tunnel (Table 39). Moreover, deer and bobcat and were never detected in the vicinity of the northern linkage (Tables 17, 18). More species were detected along Harbor Boulevard in the vicinity of the southern choke point (Table 17). This choke point, which constitutes the DPW property on the east and west sides of Harbor Boulevard, contained evidence of bobcat, coyote, deer, fox, opossum, skunk, and raccoon. Coyote and deer were recorded making surface crossings over Harbor

Boulevard at this location. Although no road-killed deer were found along this stretch of road, there were many reports of wildlife-vehicle mortality involving coyotes (see Recommendations for proposed improvements to this southern choke points).

### Skyline Trail

The second area of concern is along the Skyline Trail between Powder Canyon Open Space and Hacienda Boulevard (Figure 9). Human activity throughout this area is extremely high and index values for dogs were highest along this stretch (Figure 9: transects Powder Canyon West and Skyline Trail East). In addition, the open space within this stretch is characterized by a narrow east-west running ridgeline bordered by canyons that drop steeply to the north and south. While the ridgeline is essentially entirely comprised of the Skyline Trail, the side canyons do support some habitat. This stretch is most critical to bobcats, since this section received the lowest average index within the entire corridor (Figure 14). Interestingly, sections within the corridor displaying low bobcat track indices contained high levels of dog activity (Figure 27).

### Hacienda Boulevard to Colima Road

The third critical area is the stretch of open space between Hacienda Boulevard and Colima Road (Figure 10). We envision two areas of concentration of movement across Hacienda Boulevard to Colima Road, north and south. The northern movement route is along the Skyline Trail between the Hacienda Boulevard equestrian tunnel and the Colima Road equestrian tunnel. Human disturbance and habitat degradation on this segment of trail are the major threats to animal movement and may explain why no bobcat or fox activity was recorded along this stretch.

The southern movement route extends along Skyline Drive and west into San Miguel Canyon. The eastern portion of this movement route is characterized by low-density housing but it is not a significant barrier to movement. Bobcat activity was documented on the east side of Hacienda Boulevard, just north of the Skyline Drive and Hacienda Boulevard intersection (Table 24). Bobcat activity was also documented on the west side of this intersection, indicating that movement is occurring at the crest of the hill where Skyline Drive and Hacienda Boulevard meet. Therefore, when animals are travelling east to west along the corridor through this section, we predict movement west along Skyline Drive, descending into San Miguel canyon in the southwest portion, and finally through the Service Tunnel under Colima Road (Figure 11).

## CONCLUSIONS AND RECOMMENDATIONS

Although restoring critical areas within the corridor may seem daunting, several measures can be made to ensure that current and future impacts to the corridor allow for continued movement of species between patches.

### Section 1: CA 91 to Carbon Canyon Road (CA 142)

The eastern edge of the Puente/Chino Hills corridor is the most critical, and probably the only, link that will ensure exchange of individuals between the Santa Ana Mountains and eastern Chino Hills. Due to the extensive nature of urbanization surrounding the hills, the only option for dispersing individuals to leave the Puente/Chino Hills is through the Coal Canyon Biological Corridor. In fact, telemetry data has validated juvenile coyote dispersal from the Chino Hills across CA 91 (Lisa Lyren, personal communication) .

While additional linkages between the Puente/Chino Hills and larger natural areas may exist, such as the San Gabriel River to the San Gabriel Mountains, they involve extensive distances of travel. The San Jose Hills, a patch of open space in close proximity to the Puente/Chino Hills, is effectively isolated by urban development (Figure 1). Further, movement from the San Jose Hills to the San Gabriel Mountains is just as improbable.

The Prado Flood Control Basin is separated from the Chino Hills by CA 71 (Figures 1, 5). Despite carnivore movement across CA 71 between the Chino Hills and Prado Basin, movement beyond Prado basin is unlikely, as the remainder of Prado Basin is surrounded by urbanization and agriculture. This does not entirely mean that these areas will not experience movement of individuals into or out of a locale, but rather that species attempting this will most likely be those that can travel extensive distances and are compatible to human presence.

As a result, the Coal Canyon Biological Corridor represents the best available, and perhaps only link between the Puente/Chino Hills and larger areas of habitat. With the exception of CA 91 through Santa Ana Canyon, the Chino Hills and Santa Ana Mountains are almost physically intact (Figure 4). Movement between these two patches is occurring but there are limitations. Obviously, the prime threat to this connection is development. Currently, negotiations are underway to acquire and preserve properties on both the north and south side of CA 91, thus providing a secure connection between the Chino Hills and Santa Ana Mountains.

Once the Coal Canyon Corridor is secured, several measures can be undertaken to enhance the connection. First, eliminating traffic at the Coal Canyon Road off-ramps and underpass would reduce noise, vehicle activity, and the probability of wildlife-vehicle incidents. Second, the current fencing design presents a barrier for wildlife attempting to use the underpass. While certain species are utilizing the culvert (91 East) adjacent to the bridge, other species such as deer may be deterred due to its low height and long length. Rerouting the fencing so that animals can travel under the bridge while being prevented from accessing the freeway would allow for a wider range of species to cross under CA 91. Obviously, funneling animals through the underpass must involve closing the exit. Finally, natural cover should be provided through the underpass so that any animal attempting to utilize it does not have to cross a large area devoid of vegetation. Furthermore, native cover may attract animals to the entrance, thus increasing the likelihood that they will find the entrance and attempt a crossing.

Several modifications to the existing conditions on CA 71 are also necessary to reduce wildlife-vehicle collisions. Recommendations in regards to this freeway will be presented at the completion of the radio-telemetry study.

Generally, section 1 contains the majority of protected open space within the entire Chino/Puente Hills, largely due to Chino Hills State Park. All of the major canyons have evidence of bobcat, coyote, and fox. Mountain lion sighting and sign have also been recorded over the past two years. Clearly, this area, combined with section 2, represents the most crucial block of core habitat within the Puente/Chino Hills.

## Section 2: Carbon Canyon Road (CA 142) to CA 57

Development threats along Carbon Canyon Road are encroaching on the remaining open space between the cities of Brea and Chino Hills. The increasing urbanization throughout this area has resulted in increasing traffic on Carbon Canyon Road. Although this roadway is only two lanes, wildlife mortality through road kill is still occurring. Part of this may be attributed to the lack of underpasses along this stretch of road, thus forcing animals to make potentially dangerous at-grade, or surface, crossings.

Six underpasses were monitored between Carbon Canyon Regional Park and Sleepy Hollow (Figure 6). Two of these culverts (Monterey East and West; connecting Carbon Canyon Regional Park and the Olinda Heights development) have been filled by dirt due to nearby development. In light of this, any animals attempting to cross this stretch of road will be forced to make an at-grade crossing. However, given the future plans for a residential area at this site, animals will most likely cross to the east of this location, at the western entrance to Chino Hills State Park. Ultimately, as traffic along this road increases, there will be a need for fencing directing animals to new culverts, in order to reduce the possibility of an animal being struck by a vehicle.

Further east, between Chino Hills State Park and Olinda Village, the only option to crossing the road is to make a surface crossing. Indeed, track stations have recorded coyotes making these attempts (Table 9). Carbon Canyon Road is not the barrier that CA 91 is: it is two lanes wide, the traffic volume is lower, and speeds are reduced. However, given increasing traffic volume, any upgrades to this road will require adequate crossing structures.

It is difficult to determine what exact routes animals will take during travels from one side of Carbon Canyon Road to the other. As track stations along Carbon Canyon Road demonstrated, many of the side canyons perpendicular to the road are being used by a variety of species. However, two particular areas along this road are critical in maintaining connections between the major drainages to the south and east (Telegraph and Soquel Canyons) and the north and west (Sonome and Tonner Canyons). These locations are essential primarily due to their connectivity value to bobcats. The first connection is through the western end of Chino Hills State Park, along the citrus grove. Citrus Grove East culvert had a high degree of bobcat activity (Tables 37, 38) and connects Telegraph Canyon on the south with newly acquired State Park lands to the north.

The second connection between major drainages to the southeast and northwest of Carbon Canyon Road is between Olinda Village and Sleepy Hollow. The County Line culvert at Sleepy Hollow also received bobcat activity (Tables 37, 38) and is critical in maintaining connections between Soquel Canyon to the south and Lions Canyon to the north. Although there is no direct link between Soquel Canyon and Sonome Canyon, many of the side canyons extending out of Carbon Canyon provide the opportunity for movement between Soquel and Sonome Canyons. Furthermore, because the Sonome Canyon region has the highest bobcat track indices throughout the entire corridor (Table 11), it is essential that connections to this locality are preserved so that dispersal of bobcats into and out of Sonome Canyon can continue. Additionally, the presence of mountain lion scat in Carbon Canyon emphasizes the fact that if development continues along this road, valuable connections may be severed.

Although bobcat activity was not recorded on the Carbon Canyon Road track stations between Olinda Village and Chino Hills State Park, coyotes were detected (Tables 9, 10). Since there are no culverts along this stretch of road, all crossing attempts are made at-grade. Again, increasing traffic volume may have a significant impact on wildlife mortality along this stretch of road.

Further west, the Puente/Chino Hills corridor is bisected by CA 57 (Figure 7). The open span bridge over Tonner Canyon provides unrestricted access to adjacent open space. This is the only underpass under CA 57 that is being used by wildlife, and it is therefore a choke point in that there is only a single option to cross the freeway (aside from attempting a surface crossing). However, because Tonner Canyon is a large, spanning bridge, movement currently is not restricted as much as other choke points along the corridor (Tables 14, 15, 16).

Although bobcat activity was concentrated along Tonner Canyon Road, future plans for development will most likely reduce the likelihood that bobcats will continue to use this route. Consideration should be given to revegetating the riparian area along the streambed, as oil company activities have severely degraded this portion of the canyon.

## Section 3: CA 57 to Harbor Boulevard

The majority of this section is located on lands owned by Shell Oil Company and was not surveyed. Given the degree of open space and lack of development in this section, it is likely that Shell Oil property supports species commonly found throughout Tonner Canyon. Movement through this area is unrestricted until Harbor Boulevard is reached. This 4-lane road receives a high volume of traffic, and when combined with the encroachment of development from both north and south, represents the first significant barrier to wildlife movement from east to west (Figure 8).

Although raccoons and skunks used the equestrian tunnel (Table 39), its position along Harbor Boulevard does not allow for a greater number of species to utilize it. Furthermore, the lack of fencing to direct these animals through the underpass likely contributes to the road kill mortality (e.g. coyotes). This does not mean that fencing should be placed along the entire stretch of Harbor Boulevard. Rather, fencing should be installed along Harbor Boulevard adjacent to the equestrian tunnel to funnel animals through it.

Ideally, the southern portion of the Harbor Boulevard choke point should also contain some type of underpass, preferably large enough to facilitate deer movement. Fencing along this stretch of road should only be done in the event that an underpass is constructed. Although fencing without an underpass would more than likely reduce, if not eliminate, road kill along this stretch of road, it would create a barrier in itself by blocking all movement across Harbor Boulevard. If there was fencing on the southern portion, yet no culvert, then the sole crossing point at Harbor Boulevard would be the equestrian tunnel to the north, which receives limited carnivore usage. In addition, movement between the southern portion and the northern portion is unlikely due to the intervening urban development.

Aside from adding fencing along the northern section of Harbor Boulevard, natural cover should replace any form of landscaped vegetation surrounding the equestrian tunnel. Throughout the corridor, bobcats more frequently used underpasses with lower levels of landscaping surrounding the entrance.

### Section 4: Harbor Boulevard to Hacienda Boulevard

The area between Harbor Boulevard and Powder Canyon Open Space is mostly comprised of low-density housing. Currently, the presence of houses in this area does not seem to be a significant barrier to movement. The Edison easement at the western boundary of the Vantage Pointe Community (Harbor Central-West transect) received activity by bobcats, coyotes, foxes, and skunks (Tables 17, 18, 19) and represents the eastern extent of carnivore movement into Powder Canyon (Figure 8). The small canyons to the north and west of this transect (and the Edison easement) offer the most likely movement routes into Powder Canyon.

Since Fullerton Road is a small, two-lane road that receives limited traffic, it is unlikely that this is a major barrier to carnivore movement. The winding nature of this road between Harbor Boulevard and East Road prevents vehicles from travelling at excessive speeds (Figure 9). Coyote activity was documented along Fullerton Road at two individual scent stations (Pasture and Powder Canyon SE) (Table 20). While the threat of increased traffic volume is not imminent, future monitoring of road kills should be investigated.

Powder Canyon Open Space, in conjunction with Schabarum Regional Park to the north, provides a relatively large area of habitat for resident wildlife populations. With the exception of raccoons and weasels, all of the species detected throughout the Puente/Chino Hills were found in Powder Canyon Open Space. Certain species, however, exhibited lower indices relative to other areas of the corridor, namely bobcats and raccoons (Figures 14,19).

Further west, as the corridor becomes more constricted, human activity increases. The side canyons extending north and south of the Skyline Trail represent the best available habitat at the western end of section (Figure 9). It is critical that these canyons be protected in order to alleviate the impacts of human activity along the Skyline Trail.

### Section 5: Hacienda Boulevard to Colima Road

Although Hacienda Boulevard receives a relatively high volume of traffic, there is no serious threat to wildlife-vehicle collisions. This is largely due to the fact that Hacienda Boulevard is steep and somewhat winding as it crosses the corridor between the Hacienda

Boulevard equestrian tunnel and Skyline Drive (Figure 10). As defined earlier, there are two primary routes of travel within this section: a north route and a south route.

Animals attempting to cross Hacienda Boulevard to gain access to the northern route are either travelling through the Hacienda Boulevard equestrian tunnel or across Hacienda Boulevard (make a surface crossing). Since the only species detected using the equestrian tunnel were raccoons and cats (Table 40), it is likely that other animals are making surface crossings in this area. Evidence for this is that scent stations on each side of Hacienda Boulevard experienced high visitation by species, especially coyotes, not using the tunnel. The design of this underpass is similar to the equestrian tunnel under Harbor Boulevard in that it lacks adequate fencing to direct animals to the tunnel. We suggest that fencing on both sides of Hacienda Boulevard in the vicinity of the equestrian tunnel be established, so as to reduce the possibility of future road kill. In addition, the western entrance to the tunnel lacks adequate levels of natural cover. By revegetating the area surrounding this entrance to this underpass, in combination with proper fencing design, more species may attempt to utilize this underpass.

The second area that we have targeted as a major crossing point across Hacienda Boulevard is at the intersection of Skyline Drive and Hacienda Boulevard. This area is especially critical as it was the only sampling location along this stretch of road where bobcat activity was recorded. Although an underpass installed under Hacienda Boulevard north of Skyline Drive might be used by wildlife, fencing to direct animals to the underpass would be difficult. For example, Skyline Drive is a small, graded road that animals will travel down to cross Hacienda Boulevard at the intersection. To direct animals through a tunnel under Hacienda Boulevard, a fence would have to be constructed across Skyline Drive to prevent animals from simply walking down the road. This, obviously, is not feasible. Even if wing fencing was constructed just directly above an underpass at Hacienda Boulevard, a surface crossing could still be possible, and the design would mirror current conditions at the equestrian tunnels under Harbor Boulevard, Hacienda Boulevard, and Colima Road. In other words, the current conditions at this southern crossing point seem adequate.

Between these two major crossing points there are many side canyons extending away from Hacienda Boulevard. Sampling between the north and south locations occurred along the stretch of Skyline Trail paralleling Hacienda Boulevard (Hacienda Boulevard transect) (Figure 10). Coyotes were detected traveling along this stretch of trail, although visitation rates to scent stations along this stretch were low. Therefore, surface crossings over Hacienda Boulevard along the stretch between the equestrian tunnel and Skyline Drive is limited, and probably not as significant as crossings to the north and south. The best strategy to avoid turning Hacienda Boulevard into a significant choke point is to continue purchasing lands along the roadway, so that development does not block any wildlife movement across this road.

Once animals have crossed Hacienda Boulevard, there appear to be two primary routes of travel from east to west - through the northern half of the section or through the southern portion. As mentioned earlier, scent stations throughout the northern half of this section along Skyline Trail (Hacienda Boulevard and Skyline Trail West transects) were never visited by bobcat or fox (Table 24). Indeed, this area is generally lacking in adequate cover and receives a great deal of human activity. This does not mean that movement through this portion of section 5 is not occurring, although even coyote indices were fairly low. Rather, the northern half of this section represents a buffer to habitat south of this area.

Habitat protection in the southern portion of this section, although mixed with low-density housing toward Hacienda Boulevard, is critical in maintaining resident populations of wildlife. For example, the least disturbed portion of this section occurs in San Miguel Canyon. Of the transects throughout section 5, the transect through this canyon (Whittier East) recorded the highest track and scat indices for bobcats, coyotes, and foxes (Tables 24, 25) and the highest track indices for raccoons and skunk (Table 24). Incidentally, dog indices were lowest along this transect. Therefore, the purchasing of lands for further habitat protection would help to secure the remaining areas of open space within this section.

### Section 6: Colima Road to Turnbull Canyon Road

Sampling within this section was confined to the eastern half due to restrictions on access to Rose Hills Memorial Park in the western half (Figure 11). The existing open space throughout Rose Hills Memorial Park is characteristic of the habitat within the portion of this section we sampled (City of Whittier property). Therefore, we would assume that species we detected on transects established throughout the eastern half of this section should also occur in the western portion of this section.

There are two underpasses located under Colima Road (Figure 11). The northern underpass is the Colima Road equestrian tunnel. This tunnel was used by opossums, raccoons, skunks, dogs, and cats (Table41). The design is similar to those equestrian tunnels along Hacienda Boulevard and Harbor Boulevard in that there is no fencing to prevent wildlife from making an at-grade crossing of Colima Road. Scent stations on each side of the road recorded coyote visits, indicating that there is activity across the road. Coyote movement across Colima Road was further substantiated by numerous road kills at this location over the course of this study. By establishing fencing along both sides of the road, animals will be prevented from attempting surface crossings. The eastern entrance of this tunnel is surrounded by adequate cover, but the western side is lacking. Although this equestrian tunnel is being utilized by more species (5) than the Harbor and Hacienda equestrian tunnels (2 species each), two of the five species detected under the Colima Road tunnel are domestic animals (dogs, cats). Additionally, no bobcats, coyotes, deer, or foxes were detected using this tunnel. The proximity of this underpass to residential development is more than likely contributing to species usage.

The southern underpass (service tunnel) was used by bobcats, deer, foxes, opossums, and skunks (Table 41). The lack of domestic species (cats, dogs) at this underpass is due to the lack of influence from residential development. When compared to the equestrian tunnel to the north, the degree of wildland surrounding the service tunnel underpass was similar to the degree of residential area surrounding the equestrian tunnel. Therefore, this provides a means of comparing species usage of underpasses in two different settings (residential and wildland) but along the same stretch of road. Such a scenario is not available on Hacienda Boulevard and Harbor Boulevard.

The eastern portion of section 6 contains the highest bobcat indices west of Sonome Canyon and the highest levels of deer activity in the entire Puente/Chino Hills (Figure 14). Combined with the fact that evidence of coyote, fox, opossum, raccoon, and skunk were recorded on at least one transect, the wildlands in this section represent a core area of habitat within the Puente/Chino Hills. Currently, section 6 is large enough to still have areas that receive little impact from human-associated influences. These areas, including the City of Whittier property and wildland spaces throughout Rose Hills Memorial Park, restrict human activity and therefore are more likely to contain higher abundance of mammals.

Recent plans have been made to incorporate the City of Whittier property into a multi-use recreation area. Not only would human activity interfere with current relatively undisturbed conditions throughout this property, it would disrupt wildlife movement through the Service Tunnel underpass as animals attempt to cross underneath Colima Road. Since this underpass is the only link between habitat to the east (San Miguel Canyon) and habitat to the west (Arroyo Pescadero Canyon), human disturbance should be kept to a minimum. We strongly recommend that all efforts to allow human activity to occur throughout this area be stopped.

### Section 7: Turnbull Canyon Road to Workman Mill Road

Due to the excessive winding of Turnbull Canyon Road, it is not a significant barrier to wildlife movement (Figure 12). No road kills were detected along Turnbull Canyon Road during the course of this, although coyote and deer road kills have been documented (Swift et al. 1993). Species detected along this road included bobcats, coyotes, fox, opossum, raccoons, and dogs (Tables 29, 30). Generally, the habitat surrounding the road consists of non-native grassland and contains little cover. However, several of the side canyons that cut across Turnbull Canyon Road provide some sort of vegetative cover. These areas are the most likely crossing locations for animals attempting to cross Turnbull Canyon Road.

Further west, sampling was restricted to the Skyline Trail due to access restrictions from Rose Hills Memorial Park (Figure 13). This stretch of trail is fenced in for some portions and travels through the Los Angeles County Landfill, thus not truly representing the array of habitat found throughout this section. Although sampling along the Skyline Trail did not detect bobcats, the stretch to which sampling was confined was not representative of habitat commonly associated with bobcat movements. Bobcat sign was detected in Sycamore Canyon during an initial inspection midway through the study. Although Sycamore Canyon was not surveyed (because it was purchased near the end of field surveys) several visits were made to observe evidence of mammals, particularly bobcats. In addition to bobcat sign, we detected evidence of coyote, deer, and fox. We conclude that this area represents an important area of habitat for resident populations of wildlife and that a strong effort should be made to purchase lands linking Sycamore Canyon with larger areas of open space to the east.

A major barrier to movement is the presence of fencing between Rose Hills Memorial Park and the Los Angeles County Landfill. This area is significant in that it connects Sycamore Canyon with many of the smaller canyons extending north and east of the Skyline Trail. The portion of the Skyline Trail that travels between these fences (Landfill East transect) received low visitation rates to scent stations. We recommend that breaks in the fence be installed so as to limit public access but allow for wildlife movement.

The open space contained within the western Puente Hills ends abruptly at Workman Mill Road (Figure 3). West of this roadway, the landscape is dominated by intense urbanization, representing a significant barrier to any wildlife movement. Although movement beyond Workman Mill Road and I-605 is likely for some species detected in this study, particularly coyotes, opossums, and raccoons, the extent of their travel into the urban matrix is not sufficient enough to allow them to reach other significant areas of habitat.

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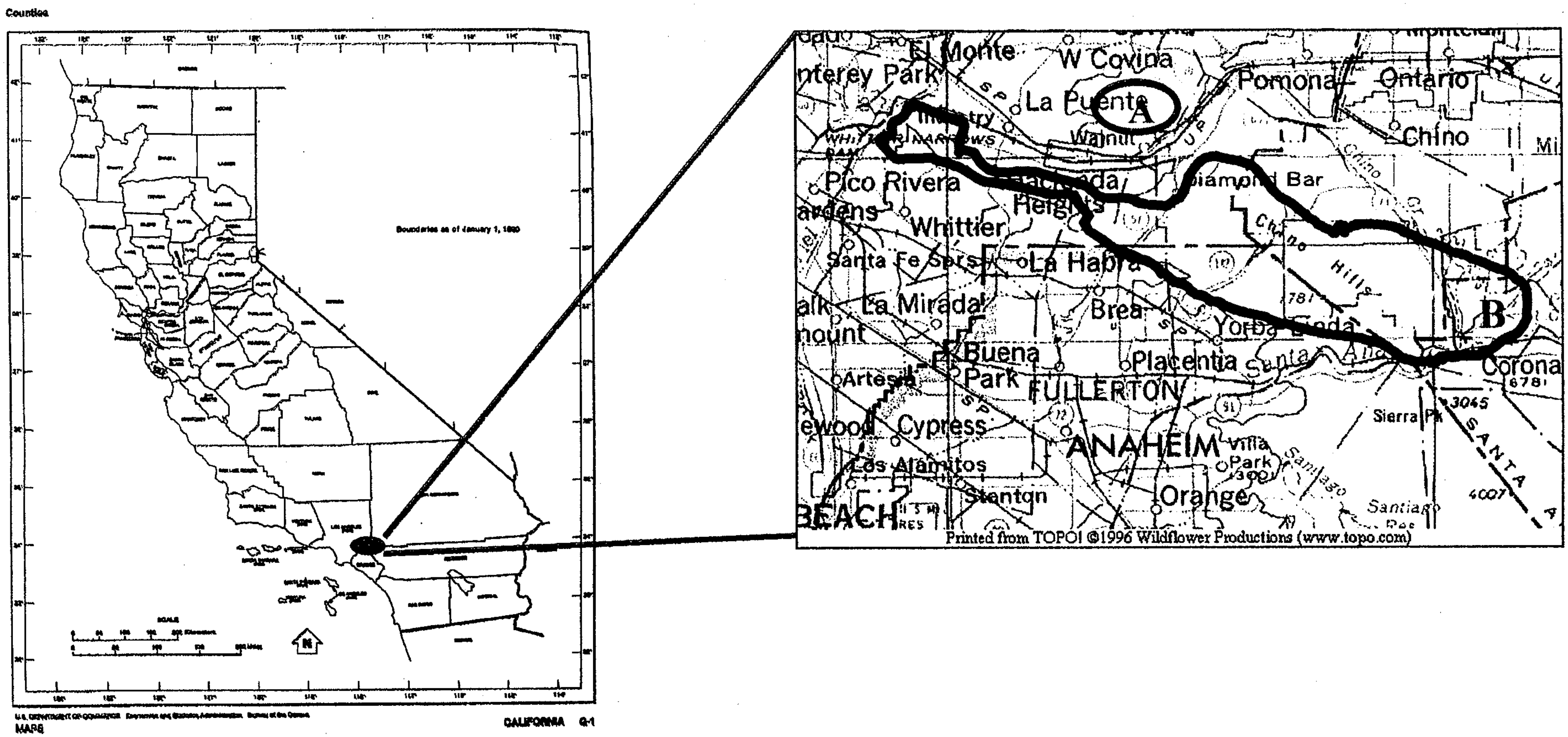
Figure 1. Location of study area in the Puente/Chino Hills, including San Jose Hills (A) and Prado Flood Control Basin (B).



Counties
Boundaries as of January 1, 1990
CALIFORNIA G-1
MAPS
W Covina
El Monte
Pomona
Ontario
Chino
La Puente
A
Walnut
Diamond Bar
Pico Rivera
Whittier
Hacienda Heights
La Habra
Chino Hills
Santa Fe Sprs
La Mirada
Brea
Yorba Linda
B
Buena Park
Placentia
Corona
Artesia
FULLERTON
Sierra Pk
Cypress
ANAHEIM
Villa Park
Los Alamitos
Stanton
Orange
BEACH
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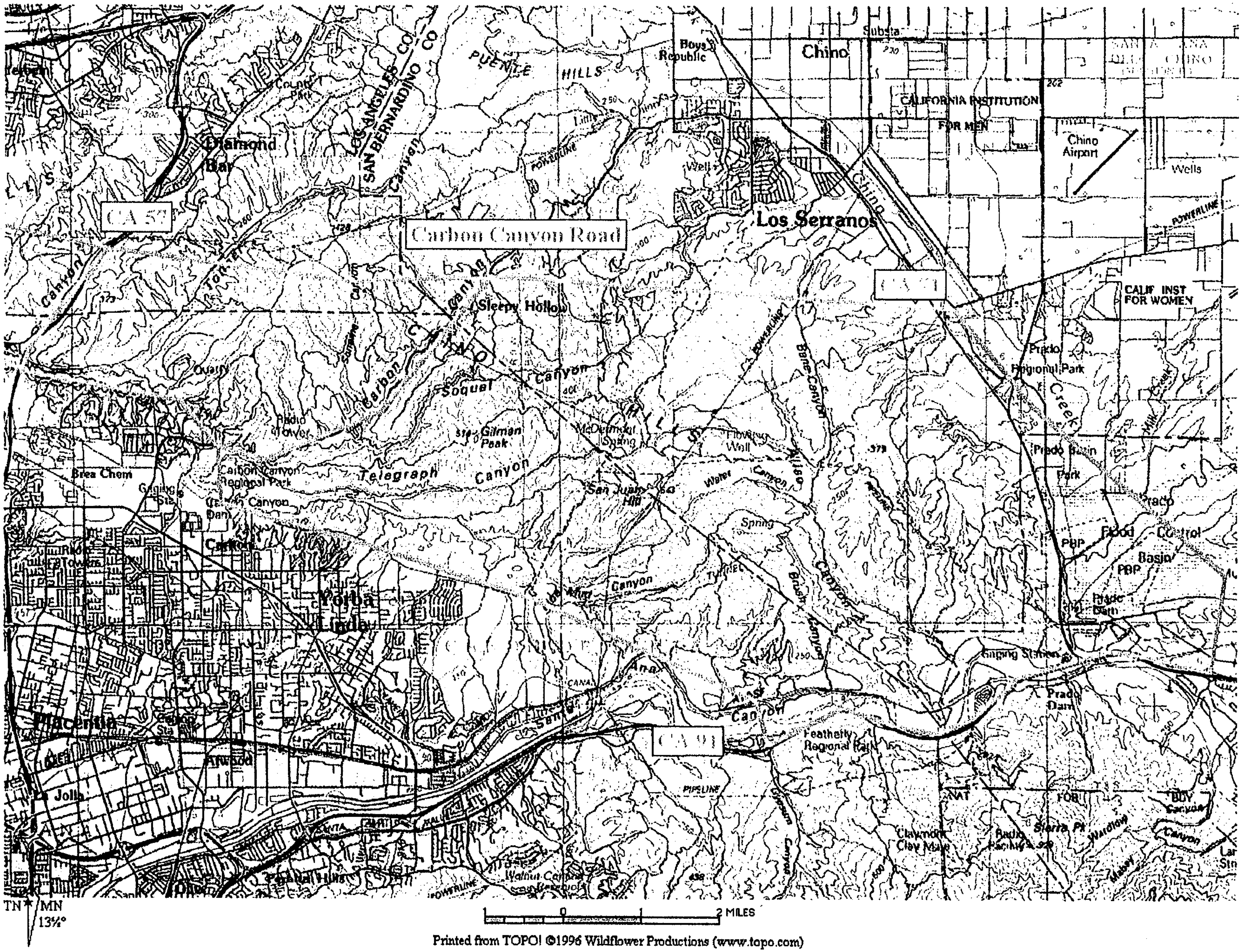
Figure 2. Location of eastern sections (1: CA 91-Carbon Canyon Road (CA 142); 2: Carbon Canyon Road (CA 142)-CA 57) and roadways.



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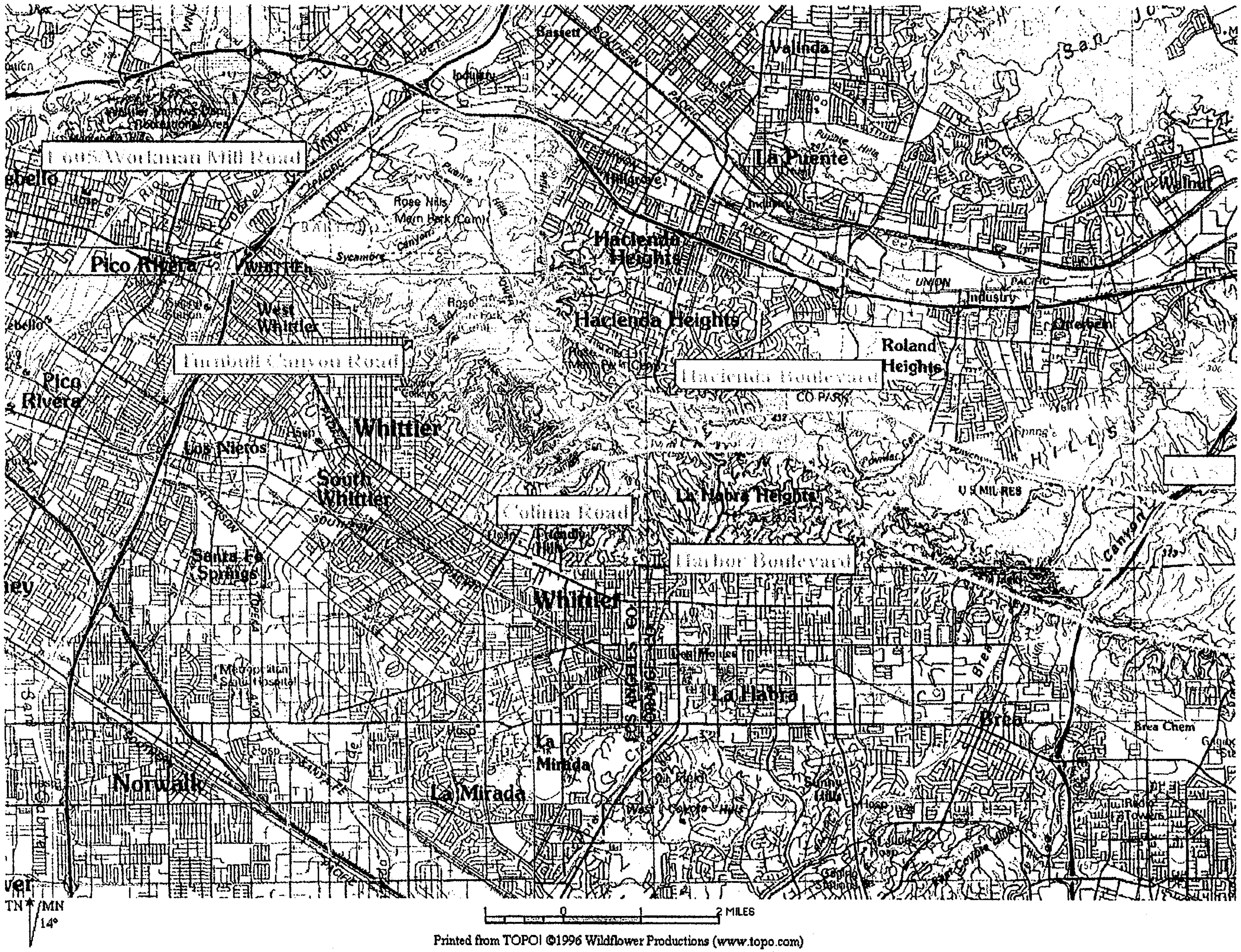
Boys Republic
CALIFORNIA INSTITUTION FOR MEN
Chino Airport
Wells
Los Serranos
CALIF INST FOR WOMEN
PUENTE HILLS
LOS ANGELES CO
SAN BERNARDINO CO
Diamond Bar
CA 57
Carbon Canyon Road
CA 71
CA 91
Sleepy Hollow
Soquel Canyon
Carbon Canyon
Gilman Peak
Telegraph Canyon
Carbon Canyon Regional Park
Brea Chem
San Juan Hill
Bane Canyon
Aliso Canyon
Brush Canyon
Prado Regional Park
Creek
Prado Basin Park
Flood Control Basin
Prado Dam
Featherly Regional Park
Yorba Linda
Placentia
Atwood
Gypsum Canyon
Claymont Clay Mine
Sierra Pk
Wardlow
TN
MN
13½°
0
1
2 MILES

Figure 3. Location of western sections (3: CA 57-Harbor Boulevard; 4: Harbor Boulevard-Hacienda Boulevard; 5: Hacienda Boulevard-Colima Road; 6: Colima Road-Turnbull Canyon Road; 7: Turnbull Canyon Road-Workman Mill Road/I-605) and roadways.

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